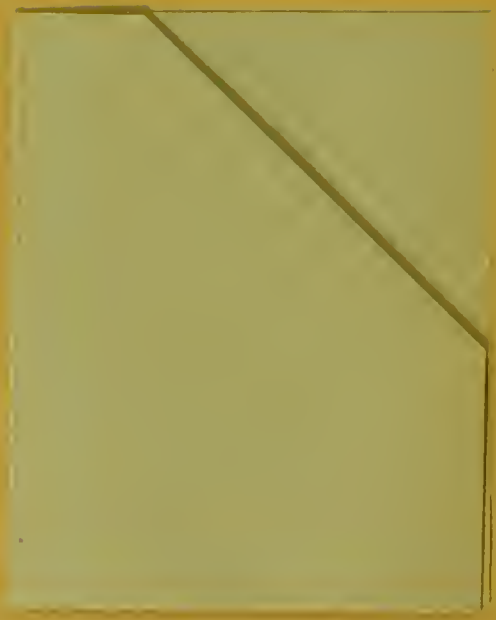

THE MEDICAL HISTORY OF THE SOUTH AFRICAN WAR.

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THE MEDICAL HISTORY OF THE SOUTH AFRICAN WAR.

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PART I.

CHAPTER I.

Introduction.

Disease in an army in the field offers a very wide field for investigation. It is hardly possible to name any common ailment which may not be affected, either in its incidence, clinical features, or severity, by the special conditions of active service, exposure, fatigue, monotonous and at times limited diet, increased chance of contagion, and the like. Such an investigation, however, presupposes careful observation and accurate record before the results are of much value—two conditions which demand time for their fulfilment, while on active service the first essential must invariably be the speedy succour of the sick and wounded, a necessity to which all else must be subordinated.

Hence in such a campaign as the South African War, as indeed in all serious operations, where the medical staff must always be fully employed with work that cannot be delayed, it is not possible to obtain satisfactory material for the complete investigation of the effects of service on the less important ailments. Here and there individual medical officers may have been so situated as to be able to observe and record their experiences over limited areas and comparatively small numbers of men. Such observations, however, can only rarely admit of a general application, and must usually be recorded as the results of individual experience only. In the late war a considerable proportion of the medical *personnel* had but a limited acquaintance with the varying facies of disease in Europe, and none with its vagaries in tropical or subtropical countries. Hence much that appeared to them to be new

and important was but a repetition of the previous experiences of many observers.

The investigation of the effects of active service in the less serious diseases is, however, a matter of academic rather than of practical interest. The important questions are those concerned with the diseases which are invariably the most important causes of inefficiency and mortality in an army in the field—enteric fever and dysentery.

The medical history of the South African War must therefore be limited to the fullest consideration which the material available makes possible of those epidemic diseases—enteric fever, its congener, simple continued fever, and dysentery; to notes on the few diseases which appear to be special to South Africa, with some reference to such minor ailments as assumed any degree of importance.

The first essential to the understanding of the disease-history of the campaign would appear to be some knowledge of the normal incidence of disease in South Africa among the garrison during peace, and in the previous campaigns in that country.

One finds, on comparing the late war with previous campaigns in South Africa, that the same general features are evident—the prominence of continued fever and dysentery, with little serious disease beyond this. Why this should be the case seems clear if the disease conditions among the civil population be considered in relation to the topography and climate.

A comparatively full account of the conditions obtaining in the civil population before the war is therefore given in Chapter III. It is sufficient here to say that enteric fever and dysentery are endemic throughout the whole area, frequently, it is true, with a comparatively small incidence, but at times breaking out in epidemic form. No class of the community is exempt; Africanders as well as Europeans, black and white, all suffer from these diseases. Nor is enteric fever specially an urban disease; on the other hand, it is at least as frequent on the scattered farms as in the towns or villages; it is a constant cause of illness in the native locations, and is at times also epidemic in the native kraals.

Here we have two infectious diseases, both spread by human dejecta, and in conjunction a sanitary system which to call imperfect is almost a compliment. In every respect the systems (where they exist) are inefficient. Provision for the efficient removal of excreta has hardly been considered; among the native population outside the towns or locations none whatever exists, nor do the habits of the natives demand any such accommodation. Practically no steps are taken to obviate a general fouling of the ground from slop-water, kitchen refuse, and the like, while the

methods of collection, storage, and distribution of water are, almost without exception, of the most primitive description.

From these two factors—endemic disease and imperfect sanitation—it results that it is hardly possible to select any one area of the whole field of our operations, and say that there at least all epidemic disease must have been imported.

A third factor lay in the exceptional constitution of the field force. In most of our previous campaigns a large proportion of the force consisted of seasoned soldiers—men who had served abroad, where enteric fever is more prevalent than in England, where the more susceptible were either eliminated by death or had acquired by attack a degree of immunity against enteric fever. It is, of course, the case that this point may be pressed too strongly. Before the war there was evidence that service in India, that is, a previous exposure to infection, did not result in that degree of immunity of the unit as an aggregate against enteric fever in Natal, which might have been expected to show itself had the unit remained in India, and also that, as to the individual, a previous attack of enteric fever in India was more often followed by an attack in Natal than a second attack is observed in the same individual while remaining in India, and that therefore a greater incidence than usual might be expected in seasoned units proceeding to South Africa, especially under war conditions. But, apart from this, the proportion of young soldiers who had never previously been out of England was very much larger than in any previous campaign. Recruits for the Regular Forces, Militia, Volunteers, Imperial Yeomanry, all alike were young or maintaining their natural degree of susceptibility, or both.

Quite apart from the somewhat theoretical consideration of the degree of susceptibility lies the practical fact that all these young or inexperienced soldiers had everything to learn regarding their new mode of life; all the common precautions which even the careless regular soldier takes as a matter of habit had to be learned by these men. This, too, influenced the sick-rate.

The last, and not the least important factor influencing disease in the field is the sanitary organisation. In the South African field force, knowledge, experience, and ability were common among the officers of the medical service; but these powers were largely wasted owing partly to traditional obstacles, partly to the want of an adequate organisation and equipment. The traditional obstacles were these: sanitation was regarded as something of a mystery, which concerned the doctors alone. In the early stages of the war only a few commanding officers recognised that it was their business, and still fewer that it was not only their business but that of every man under them; experience before the war in South Africa

showed that this recognition was most usually found in regiments who had served in India before arrival in Africa. That this attitude lasted to the end of the nineteenth century is largely the fault of the medical service, professional pride refused to admit that a layman could deal with such a matter. Again, it was regarded as the primary duty of the doctor to cure a man after he had fallen sick, not to prevent him doing so, an idea taken from the relation of the doctor in civil life to his patient—another example of the persistence of civilian notions in military life. The last obstacle, which may also be termed traditional, was the position of the sanitary adviser, an adviser whose power of seeing his ideas put in practice depended on his personal influence. It is, of course, perfectly obvious on general grounds, as it is historically, that an adviser without personal influence, whose sole responsibility is the emission of recommendations on paper (of which an office copy is carefully filed), will at times allow himself to make recommendations which he should know are useless, if not impossible, and this for the sake of guarding himself against the uninformed criticism of some one at home. Such a procedure not only fails in producing any useful result locally, but throws discredit and suspicion on the whole body of the sanitary advisers.

The absence of an adequate sanitary organisation was not the fault of the medical service. "The fact was that in the medical service, as in every other, the contingency of expansion on a really large scale had never been contemplated by the political rulers of the country, and had consequently not entered, to any extent, into the calculations of the various departments of the War Office. The medical service was not behind the other services in this respect, nor did the response which it made to the unforeseen strain compare unfavourably with that made by the other services."[1] The trained officers of the service were only sufficient to form a *cadre*, filled up from the civil profession, and relations of doctor and patient being the essential in the popular view, the available officers (other than administrative) were distributed almost entirely to the various hospitals, at the front or on the lines of communication, where part of their duties was in connection with sanitation. It must not be forgotten that this system, inadequate as it now appears, had produced exceedingly good results in former and smaller campaigns, results which were regarded with admiration by our Continental brethren.

Many hard things have been said of our sanitation during the war. We learned much during these three years; we have been learning since, and, owing to a very fortunate combination of

[1] "*Times* History of the War in South Africa," vol. vi., p. 508.

individuals and circumstances, there is no doubt that our present standpoint is far above that from which we began the campaign. But many of the criticisms levelled against the medical service during and after the war were unjust. Some were prompted by the parochial tendency of the average man devoid of imagination; others were the habitual, probably unthinking, criticisms which we have learned to expect; others, again—the result of a supposed comparison with another nation—are known to be founded on misstatements of fact. But when the actual incidence of disease is considered in all its relations, it will be found that the results, though not such as we hope to obtain under our present organisation, are better than is generally believed, and will bear comparison with any others.

CHAPTER II.

The Incidence of Disease in the Garrison of South Africa prior to the War.

The Army Medical Department Reports are available from 1859, and contain much valuable information, both as regards incidence and mortality. But for the purpose of a comparative statement, it is always easier to obtain accurate information as to deaths than cases, and again, in considering fatal cases only, the question of diagnosis is largely eliminated, as the diagnosis has been confirmed by an autopsy. During the forty years prior to the war covered by these reports, two quinquennia—1874-78 and 1879-83—included periods of operations in the field more or less protracted, and though these two periods require special mention, yet for purposes of comparison of normal health conditions they

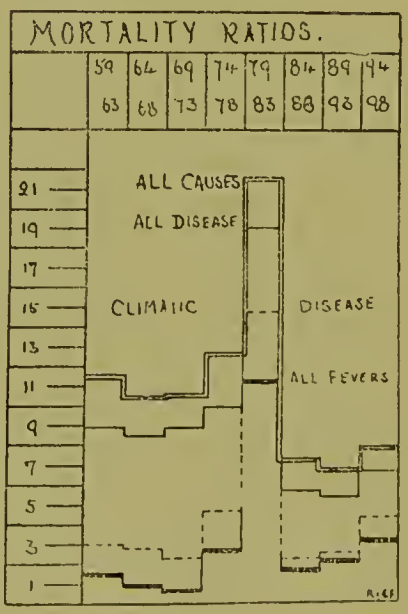

Fig. 1.

must be omitted. The table on page 8, then, shows the deaths and mortality to strength for different diseases, or classes of disease, for the first and last fifteen years of the period, and this division affords a means of comparison also between the old or long-service and the young or short-service army; while figure 1 shows the mortality per 1,000 of strength for each quinquennium during the

period for all causes, for all disease, for all climatic disease (fevers, dysentery, and diarrhœa), and for all fevers.

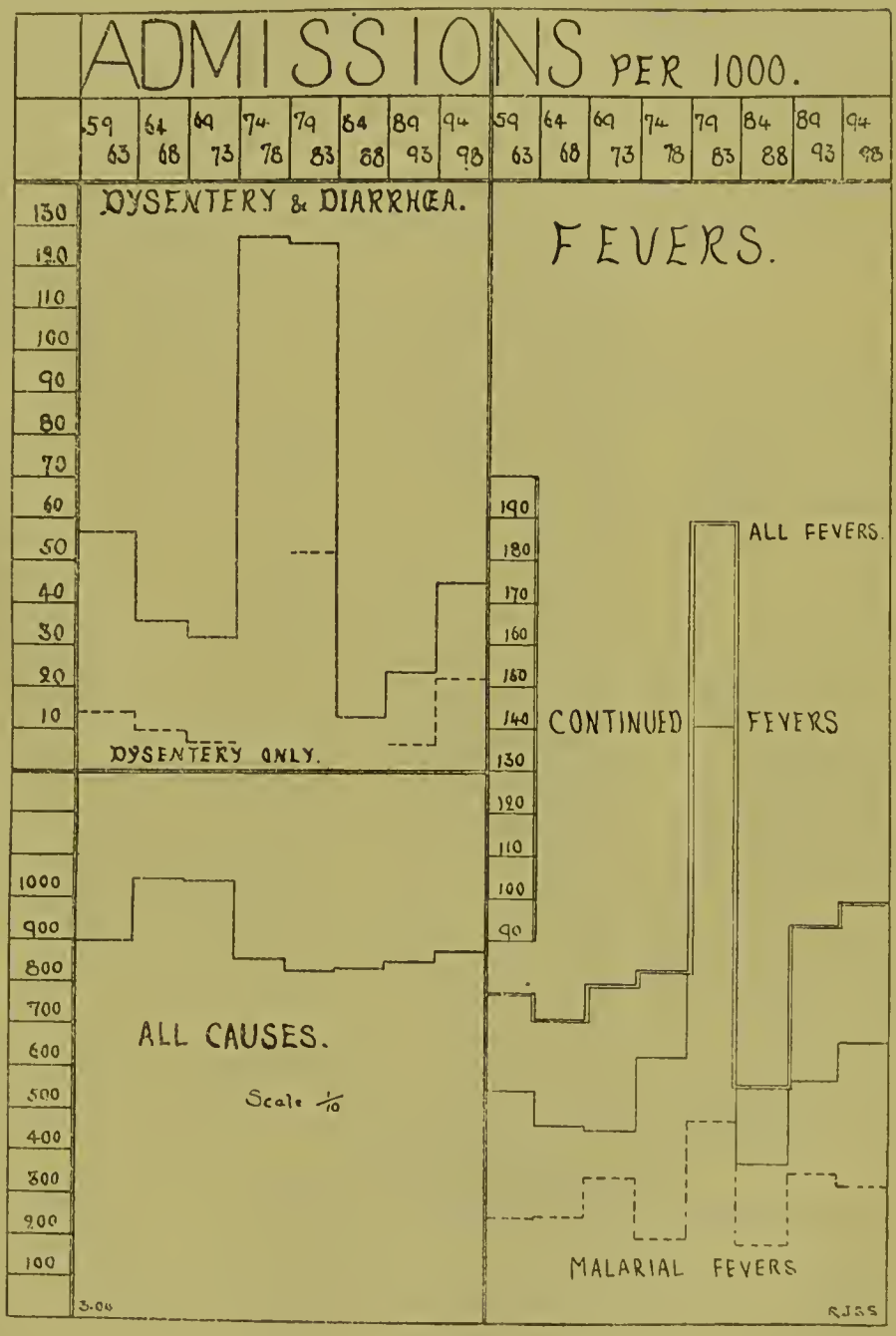

Fig. 2.

The death-rate from all causes in South Africa during the fifteen years 1884-98 was 7·37 per 1,000, practically identical with that during the ten years 1889-1898, and less than the mean death-rate of all European troops at home and abroad during the same period—viz., 9·03 per 1,000. Indeed, during that period only four foreign stations—Straits Settlements, Barbados, Gibraltar, and

Canada—showed a smaller death-rate, so that, as regards mortality, South Africa compared favourably with most foreign stations.

During the fifteen years 1859-74 the death-rate from all causes was 10·96 per 1,000, or 3·59 per 1,000 more than during the last fifteen years. From the summary given in the following table, it will be seen that there was a reduction of 5·10 per 1,000 in the mortality during the last fifteen years, as compared with the first;

SOUTH AFRICA.

COMPARISON OF MORTALITY RATES, FIRST FIFTEEN YEARS AND LAST FIFTEEN YEARS.

	1859-63 Deaths	1864-68 Deaths	1869-73 Deaths	Total Deaths	Ratio per 1,000 of strength	1884-88 Deaths	1889-93 Deaths	1894-98 Deaths	Total Deaths	Ratio per 1,000 of strength
Malarial fevers	5	3	5	13	0·21	1	—	3	4	0·07
Enteric fever	1	11	3	15	0·24	27	35	82	144	2·37
Other continued fevers	31	10	2	43	0·69	1	—	—	1	0·01
Enteritis	1	—	—	—	0·02	1	1	2	4	0·07
Perforation of intestine	—	—	—	—	—	1	—	—	1	0·01
Dysentery	21	15	5	41	0·66	2	3	13	18	0·30
Diarrhœa	8	11	2	21	0·34	—	—	—	—	—
Hepatitis	7	10	14	31	0·50	4	—	2	6	0·10
Hepatic abscess	—	1	2	3	0·05	4	1	12	17	0·28
All climatic disease	74	61	33	168	2·71	41	40	114	195	3·21
Tubercular diseases	36	38	35	109	1·76	12	5	18	35	0·58
Nervous diseases	27	20	18	65	1·05	11	9	2	22	0·36
Circulatory diseases	37	37	20	94	1·52	6	6	15	27	0·44
Respiratory diseases	24	22	11	57	0·92	16	8	10	34	0·56
Digestive diseases	11	3	1	15	0·24	3	3	1	7	0·11
Other diseases	14	7	13	34	0·55	14	14	15	43	0·71
All diseases	223	188	131	542	8·75	103	85	175	363	5·97
Poisons, including alcohol	24	15	6	45	0·72	—	1	3	4	0·07
Injuries	41	31	20	92	1·49	29	22	26	77	1·26
In action	—	—	—	—	—	2	—	2	4	0·07
All causes	288	234	157	679	10·96	134	108	206	448	7·37

SUMMARY.

Ratios per 1,000 *of Strength.*

	1859-1873.	1884-1898	1884-1898	
			−	+
Malarial fevers	0·21	0·07	0·14	—
Other fevers	0·95	2·46	—	1·51
Other climatic disease	1·55	0·68	0·87	—
ALL CLIMATIC DISEASE	**2·71**	**3·21**	—	—
Other diseases	6·04	2·76	3·28	—
ALL DISEASES	**8·75**	**5·97**	—	—
Other causes	2·21	1·40	0·81	—
			5·10	1·51
ALL CAUSES	**10·96**	**7·37**	− **3·59**	

that this reduction operated in all classes of disease except in the class of continued fevers, in which there was an increase in the mortality of 1·51 per 1,000, making the net decrease in mortality 3·59 per 1,000. This increase in febrile diseases is practically due to enteric fever alone; the probable causes will be discussed later.

The table shows sufficiently well the differences in the general, non-climatic diseases.

As regards the climatic diseases, the general incidence as given in the Army Medical Department Reports is shown in fig. 2. Malarial fevers are not endemic and have not been important at any time. The highest admission-rate for these was during the period including the Zulu and first Boer War, 1879-83, when it reached 48·08 per 1,000 of strength, with a death-rate of 0·79 per 1,000. Probably many of the cases and most of the deaths[1] were in fact due to enteric fever. Except during this period, when the coast column in Zululand probably contracted fresh infection, all the cases would appear to have been imported between 1859 and 1867, particularly in troops from China, throughout the whole period in troops from Mauritius and India, the latter source especially raising the admission-rate in 1896-97.

Dysentery and Diarrhœa.—Here the records are imperfect, as shown by the broken line, and there appears to have been some confusion about diagnosis, judging at least from the number of deaths returned as from diarrhœa[2] during the earlier years. The incidence ratios for dysentery, and for this and diarrhœa combined, fell steadily during the first fifteen years of the period. During the last fifteen years, though the mean *admission*-rate is about 12 per 1,000 less than in the first fifteen years, the combined incidence-rate has nearly doubled in each successive quinquennium. The *mortality* is entirely from dysentery, 0·30 per 1,000, while during the first fifteen years the mortality from dysentery alone was 0·66 per 1,000, and from both diseases 1·0 per 1,000, so that in this respect there is a marked improvement. Much of the dysentery during the earlier periods occurred in the troops from China and was in all probability of a severer type than that now found. As regards the diseases associated with dysentery, hepatitis and hepatic abscess, it has not been possible to obtain the number of admissions. The increase in the mortality from hepatic abscess, with a concurrent decrease in that from hepatitis, is apparently due to a difference in nomenclature, not to any difference in the real frequencies of the two diseases in each period; the total death-rate from both combined has largely diminished.

[1] *Vide infra.*

[2] Possibly some of the deaths may have been due to sprue among troops from China.

The Continued Fevers.—The only way to eliminate the difficulty of diagnosis is to take all the continued fevers together; this is, however, less likely to be wrong in the mortality than in the incidence ratios. One finds in the earlier years that the continued fevers are said to have been more frequent in regiments affected by malaria contracted elsewhere, so that some of these continued fevers may have been forms of malarial fever which did not conform to the type recognised as remittent fever. Hence the statistical distinction between the malarial and continued fevers does not appear to be absolute. But one cannot say that all the deaths recorded as from malarial fevers, especially remittent fever, should in fact have been recorded as from enteric fever. In 1879, indeed, twenty-four deaths returned as from remittent fever are referred to as probably due to enteric fever, but, on the other hand, from personal knowledge, two deaths occurred from malarial fever during the last quinquennium in which there was no doubt as to the non-enteric character of the disease. On the whole, however, as regards the deaths, there is less possibility of serious error in regarding them as all due to enteric fever than in attempting to differentiate between them. The incidence ratios are not quite so clear, and must be considered as approximate only.

As regards the continued fevers other than enteric fever—the so-called "simple continued fever" and the like—the whole evidence is to the effect that they prevail at the same seasons and in the same localities as enteric fever, and hence that the recorded distribution of the cases of enteric fever may be taken to represent that of the other continued fevers.

Enteric Fever.—The incidence in proportion to strength is much greater in Natal and Zululand than in Cape Colony. Between 1882 and 1898, of 1,130 cases returned as enteric fever, 966, or 85·5 per cent., occurred in Natal; 150, or 13·3 per cent., occurred in Cape Colony; the remaining small percentage in St. Helena and Rhodesia. The exact strengths in Natal and Cape Colony respectively are not available, but it is known that the strength in Natal was rather less than in Cape Colony, so that the actual difference in incidence is greater than these figures represent. Similarly, before 1882 most of the cases occurred in Natal or the Transvaal, though a complete numerical statement for the whole period cannot be made out. There is little doubt that about four-fifths of the cases of enteric fever in South Africa during the period (certainly between 1882-98) occurred in Natal, Zululand, and the Transvaal—that is, in the region of the summer rains.

With the exception of Eshowe, at which the maximum number of cases in a year never exceeded four, and where the garrison is small, and Simonstown, as to which there is some doubt of its

occupation by the army for the first few years of the period, cases of enteric fever have been returned every year from every station—permanent, new, or reoccupied—in which troops have been stationed during this period 1882-98. Further, during the occupation of the Transvaal, between 1877 and 1881, and the formation of small military stations in many of the towns, each of these contributed cases of enteric fever.

The fourth (1874-78) and eighth (1894-98) quinquennia of the period immediately precede a war period, and in each there is a rise in the total death-rate, an increase which is seen in each class of disease. These preliminary periods hence merit a special examination, of which the results are shown graphically in fig. 3.

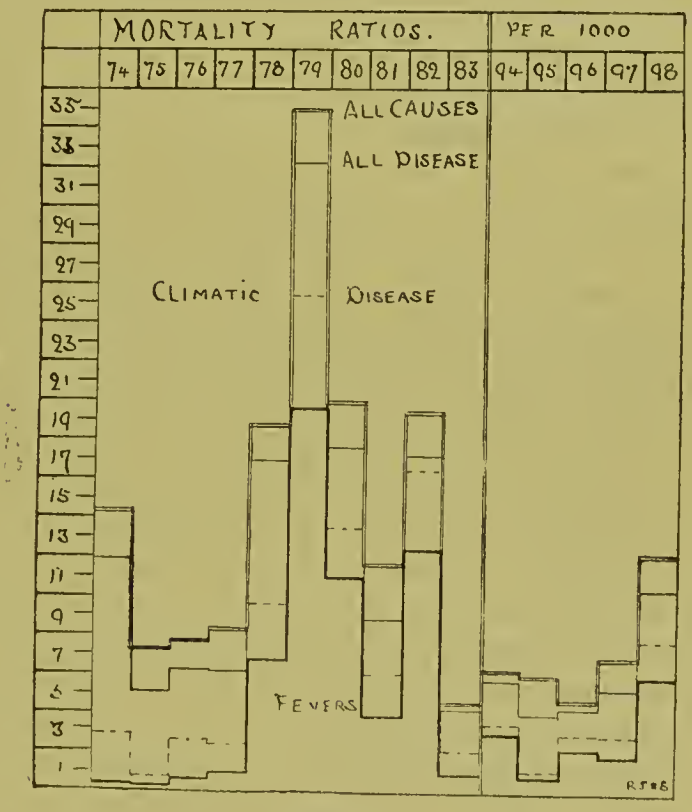

FIG. 3.

From this it appears that the increase in each of these two quinquennia was actually due to an increased incidence of disease during the last year of each quinquennium, and the detailed history of each of these periods is instructive.

In 1877 the Transvaal was annexed; new stations were opened both in Natal and the Transvaal. In December of the same year, the troops from the garrison of Cape Colony crossed the Kei river prior to the beginning of the Galaika War. During that campaign a so-called "bastard" form of enteric fever, called by some "typho-malarial" fever, prevailed among the troops engaged. It began

almost simultaneously in East London, King William's Town, and Fort Beaufort, and gradually extended to the camps in the Transkei and Ciskei. Most of the cases occurred in March, April, and May, 1878.

In August of the same year preparations were begun in Natal in view of the serious trouble with Zulus. Wood's column went to Utrecht in the same month, and an expedition was sent against Seccocoeni. All these movements had the usual consequence—an increase in enteric fever. In 1879 admissions are stated to have occurred at nearly every station (in Natal, Zululand, and the Transvaal) and on the line of march. Durban was said to have been a great focus for the distribution of the disease, and the detailed medical history of the war shows the persistence with which enteric fever occurred in an infected body of men. It is this year (1879) of the Zulu War which is responsible for the increased incidence during the period 1879-83 (fig. 2); the succeeding years of the period show remarkable variations.

In 1880 cases and deaths from enteric fever occurred at most stations in Natal and the Transvaal, most in the first quarter of the year.

War was declared on Dingaan's Day (December 16th), 1880, and small garrisons were besieged in Standerton, Marabastadt, Wakkerstroom, and Potchefstroom. Reinforcements arrived from England and India between January and May, 1881, and about 7,000 were encamped at Newcastle between March 23rd and the end of May, 1881. One of the most curious features of the case is the extraordinarily small incidence and mortality during this year as compared with the preceding and succeeding years. The only explanation that suggests itself is that as the reinforcements only began to arrive on January 21st, and continued arriving till May 15th, the greater part of them arrived after the season of greatest prevalence of enteric fever had passed. It may be noted here that the meteorological records show that in the last three months of 1880 the rainfall at Fort Napier, Maritzburg (which is fairly typical of that in Natal generally), had been much *above* the average, and that the fall in January and March, 1881, was about the average, the February fall being a little short. Now an examination of the conditions associated with the prevalence of enteric fever in Maritzburg seemed to show (Army Medical Department Report, 1898) that a good and early rainy season was associated with a shortened enteric season, and conversely.

In September, 1881, some cases of enteric fever occurred among the troops encamped at Newcastle, and thence the disease gradually spread all over Natal. The date of appearance was comparatively early. One may note here also that the August rainfall was con-

sidered above the average, which is usually small; later it was about normal.[1] A full account of this outbreak is given in the Army Medical Department Report for 1881, by Brigadier-Surgeon Wm. Skeen, M.D., and is most interesting. In 1882, 240 cases of enteric fever, with forty-seven deaths, are reported from Natal; none from Cape Colony.

In 1883 the garrison was much smaller after the withdrawal of the reinforcements, and the troops remaining were "acclimatised." The result was an exceedingly low mortality from climatic disease, including all fevers; the soil had become exhausted. With this was coupled the lowest admission-rate for all diseases occurring during the whole forty years (651·2 per 1,000).

In the period preceding the last war we find the same increase, but on a smaller scale. In 1897 there was a large increase of the garrison, and two stations, King William's Town and Ladysmith, were reoccupied. In the first the old barracks were available; in the second hut barracks were erected, as also in Maritzburg. In 1898 a further increase of the garrison took place, so that the average strength in that year was nearly double that in 1896 (increase 88 per cent.), while the accommodation was increased, as stated above. Following this, in 1898, we have an increase in the rate of mortality from fevers similar to that occurring under similar circumstances twenty years previously, and probably only less, both relatively and absolutely, because no operations in the field were undertaken during this last period.

It is, of course, possible to lay too great stress on the connection between the increase of the garrison and the increase of the mortality rates. There is much reason to believe that the prevalence of enteric fever in Natal in 1897-98 was not solely determined by the advent of fresh troops, but (like that in 1891, a year of exceptional prevalence) was partly, if not considerably, influenced by climatic conditions—that is, by a shortage of rainfall during the two years preceding (*vide* Army Medical Department Report, 1898, pp. 490 *et seq.*). It would appear to be more than a coincidence that the prevalence of enteric fever in the Galaika War of 1878 was preceded by a drought in Cape Colony in 1877.

But, even allowing for other factors, a comparison of the rates of mortality with the annual strengths suggests that an important increase of strength is associated with an increased rate of mortality, and this irrespective of actual war conditions. This is probable on general grounds; granted a country where enteric fever is endemic, where the barrack accommodation is only calculated for a small garrison, so material an increase as occurred in South Africa during

[1] The rainy season does not commence till the beginning of October.

these two years must cause a strain on the existing arrangements. When one considers the actual position in South Africa, where certainly during the years preceding the last War, and apparently also during the period preceding the Zulu War, if not during the whole interval between the two campaigns, all expenditure on military works was influenced by the idea that the garrison would be materially reduced at no distant period, one can easily understand that the existing accommodation had become imperfect in many of the details recognised as necessary for the maintenance of proper health conditions, even in the small garrison then present; and, further, that the plans for the additional accommodation, which had to be provided with the increase of the garrison, were prepared under the influence of the same idea—early reduction—and were therefore of a temporary and inadequate type.

The previous history of the military forces in South Africa, more especially during war periods, showed what might be expected in the approaching campaign. Attention was directed to these points in the "Sanitary Notes," Appendix V., of the War Office Memorandum (0.79/9706) on the Medical Arrangements for the Field Force, issued in October, 1899, and the necessary precautionary measures were also pointed out. Preventive inoculation against enteric fever was also instituted.

The following table shows the distribution of the recorded cases of enteric fever in the garrison in South Africa for the four years preceding the war, and it will be seen how much less the prevalence was in stations of the Cape Peninsula (Capetown, Wynberg, Simonstown) than in the eastern part of Cape Colony or in Natal.

There is one very broad distinction between these areas. The Cape Peninsula is within the area of winter rains; 70 per cent. of the total rainfall occurs between April and October. The Eastern Province of Cape Colony, Natal, the Orange River Colony and Transvaal, all lie within the area of summer rainfall. Grahamstown is near the dividing line. It receives 50 to 60 per cent. of its total rainfall between October and March; King William's Town 60 to 70 per cent.; Natal, the Orange River Colony, and Transvaal over 70 per cent. during this period.[1]

Our experience in the garrison of South Africa has shown that enteric fever has only been prevalent in stations in the area of summer rains, and that its occurrence in time is associated with increasing rainfall. We also know that in Bloemfontein, Harrismith, and Pretoria, all in this same area, enteric fever has been more prevalent or only prevalent at the same period. Our records

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[1] "Report of the Meteorological Commission," Cape Colony, 1897.

DISTRIBUTION OF CASES OF ENTERIC FEVER.

Year	CAPE COLONY										NATAL											
	Capetown		Wynberg		Simonstown		King William's Town		Grahamstown		Maritzburg		Ladysmith		Nottingham Road		Mooi River		Eshowe		Fort Pine	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1896 ..	11	3	6	1	2	—	—	—	—	—	23	6	—	—	—	—	—	—	3	—	—	—
1897 ..	9	2	3	—	—	—	7	3	—	—	115	6	17	1	—	—	—	—	—	—	—	—
1898 ..	2	1	[1]24	6	3	—	10	2	--	—	114	18	118	21	—	—	—	—	—	—	2	--
[2]1899 ..	5	—	6	1	—	—	46	1	12	7	53	9	196	29	7	—	5	—	—	—	—	—
Total ..	27	6	39	8	5	—	63	6	12	7	305	39	331	51	7	—	5	—	3	—	2	—

[1] An isolated epidemic, from polluted water.
[2] To October only.

Grahamstown, King William's Town, Ladysmith } Occupied May, 1897.

King William's Town.—Enteric fever prevalent in town and native kraals.

during the war showed a seasonal variation of the same type, except during the unusual conditions of the cold weather of 1900.

A series of observations made in Pretoria, where the water supply was believed to be good, showed an intimate relationship between the rainfall and the number of *Bacillus coli* found in the water supply, the result of contamination at some distance from the actual point of collection.[1]

In the Cape Peninsula the number of cases in the garrison has been too small to admit of a satisfactory determination of the seasonal distribution, but we know that the cases of enteric fever notified in Capetown between July, 1893, and June, 1897 (which may legitimately be assumed to bear some fairly constant proportion to the total cases), did not show the same relationship to the rainfall that is found in the summer rainfall area. There is but one feature common to both areas, and that is the association of a rising temperature with an increasing prevalence of enteric fever, but what influence, if any, this has on the development of the disease is so far undetermined.

But the towns of the Cape Peninsula differ from those elsewhere, in that they have a water supply which may be regarded as to all intents above suspicion. Hence one would hardly expect to find the same intimate connection in time between the rainfall and prevalence as in areas in which the water supply is invariably polluted by surface washings.

These two facts are important—the time relations between prevalence and rainfall in the area of summer rains, and the inevitable pollution which occurs of all water supplies drawn from streams, especially at the beginning of the heavy rains, when the accumulations of organic *débris* are swept into them. From the widespread prevalence of enteric fever and dysentery among all classes of the population there appears to be little need to look far for the specific contamination. It is impossible to form any other conclusion but that in many instances we have in this the cause of the outbreak of these two diseases; the further development after the introduction of the infection into a body of men may of course be conditioned by many other circumstances.

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[1] *Cf.* the account of the epidemics of enteric fever at Bar-le-Duc (*Archiv. de Méd. et Pharm. Militaire*, December, 1905).

CHAPTER III.

The Incidence of Disease among the Civil Population of South Africa prior to the War and Conditions associated with that Incidence.

A.—General Conditions.

1. Introduction.—Sanitation in South Africa was in a very backward condition, the inevitable consequence of the various factors which influenced its recent history. Until the discovery of the diamond fields and, later, of the gold fields of the Rand, communication with South Africa was slow and infrequent; there were few immigrants but those in search of health or of a problematical fortune. The predominant influence was in the hands of the "Dutch" population, descendants of the Dutch or Huguenot settlers of the seventeenth and eighteenth centuries, and retaining most of the habits and customs which their forefathers introduced with them when they first landed. As in India before the Mutiny, the white community, so much in contact with the natives and so dependent on them, conformed in some degree to their customs.

Again, the last century was one of great expansion in the various territories of South Africa; pioneers pushed out on every side, and in many of the towns of the Transvaal and Orange River Colony, besides northern Cape Colony, a good many of these pioneers, or their children, are still to be found. The rapid commercial development during the last years of the nineteenth century brought a large immigrant population, of whom a large number were of little benefit to the country, and many left South Africa during the war as "undesirables."

From these conditions it has resulted that the standard of sanitation, in the older territories and among the majority of the population, has been that of the seventeenth century, somewhat depreciated by contact with the natives, while in the newer colonies the primitive methods of the pioneers have barely been improved by their replacement by the methods common in the areas from which they came.

Further, over a large part of South Africa expense has always been an obstacle in the way of progress. Natural conditions make sanitary problems more difficult than in Europe and their solution more costly, while, on the other hand, the density of population is

so much less that the cost per head must always be considerably greater than in Europe.

2. Physical Features.—As regards the general aspect of the area of operations: from the southern border of the Great Karroo to a line on the north from the junction of the Riet and the Modder Rivers to Aliwal North: from the west coast north of Olifants River to the Stormberg in the east, the country is mainly Karroo, or Karroo and grass, with limited areas of agriculture round the towns (such as Richmond, Victoria West, or Middelburg), and especially in the valley of the Sunday River and its tributaries. North and east of these lines the country is mainly grass veldt, but includes limited agricultural districts, such as that on the Caledon River near Ladybrand, areas on each side of the Natal Government Railway, and others encircling the larger towns. The line dividing the Karroo from the veldt is very nearly that separating the area of less than 20 inches of rain per annum fromthat of greater rainfall.

South of the Karroo the country is more broken and its nature less regular; barren hills and fertile valleys are interspersed with limited areas of flatter country, more particularly towards the south-east coast-line. North of the line to Delagoa Bay lies the lower "bush veldt" and "low veldt," a wilder and even less populous district than those to the south. The Krokodil Valley and the country bordering on either side are very wild, mountainous, and broken.

3. Water Supply.—Speaking generally, South Africa is not well watered. It is a country whose permanent rivers are few in comparison to its area; one member of the well-known chain of negative clauses used proverbially to describe it speaks of "rivers without water." But this implies the second difficulty—the temporary excess of water during the rainy season, which involves the necessity of flood channels in excess of the average requirements.

A very valuable account of the water supplies of South Africa is to be found in the report on "Irrigation in South Africa" by Sir W. Willcocks, K.C.M.G.[1] After pointing out that it is what it was fifty years ago, "a pastoral country importing cereals and dairy produce and even hay from foreign countries," he points out that "the reason for this want of development of the agricultural wealth of the country lies in the fact that the rainfall of the three colonies, with the exception of the extreme south-west corner, is not only erratic and uncertain at the times most opportune for sowing, but is constant and heavy in autumn." Sir W. Willcocks'

[1] "Further Correspondence relating to Affairs in South Africa," July, 1902, pp. 37 *et seq.*

report deals, of course, with water for agricultural purposes, which differs in many ways from the supply of a potable water, but even from the latter point of view the report is both interesting and valuable.

Sources of Supply.—(1) Surface Water. (*a*) From a recognised and guarded catchment area. (*b*) From rivers. (*c*) From small streams. (*d*) From dams.

(2) Well water. (*a*) Shallow. (*b*) Deep.

(3) Springs.

(4) Rain water.

(1) Surface Water.—(*a*) Before the War, Capetown (including its suburbs) was the only place in South Africa which drew its supply from a definite area set apart for the purpose—viz., the plateau and higher slopes of Table Mountain. This area is not indeed entirely protected, as it is open to those climbing the mountain, and a proposal to close the area completely (originating with the sanitary authorities, Cape Colony) met with much opposition, and would be difficult to carry out. The supply is ample and of good quality, though during the rainy season it becomes very dark from peaty matters, and when taken on board ship and stored in iron tanks assumes a very ugly colour. The water is very soft and acts rapidly on lead piping.

(*b*) River Water.—Many of the larger towns drew their supplies from rivers: Kimberley and Johannesburg from the Vaal; Port Elizabeth from Van Sladens River; King Williamstown from the Buffalo River; Durban from the Umbilo and Umlaas; Ladysmith from the Klip River. The supply at Durban was not good: it was muddy and open to pollution. The same may be said of the supply in Maritzburg; that at Ladysmith was very bad. The others named were good supplies from comparatively large streams.

Bloemfontein.—The old supply was from wells. A scheme was inaugurated to replace this older supply by one drawn from the Modder River at Sannah's Post. The waterworks appear to have been opened in May, 1899, and part of the town was supplied with this water, but its use was not compulsory, and the older wells remained in use. Storage and filtration were imperfect. This supply was cut off by the Boers on April 3rd, 1900, and was not again available till May 10th.

Kroonstadt.—The supply was pumped from the Valsch River to some reservoirs at about the highest point adjacent to the town. The river was dammed below the point of intake, and above that point received all the drainage from the slopes north of the town, which were fissured with small dongas which had been used as latrines and rubbish shoots. The result was that the supply after rain was as bad as possible. There was no efficient filtration.

There were also the older shallow wells in use in the lower part of the town.

(*c*) From smaller streams. This is a common source.

The supply is in some instances taken direct from the stream; in other cases it is conveyed for some distance in pipes, or in an open furrow, or the two are combined, piping being used part of the way only. Protection of the catchment area is exceptional. In some instances the furrow is protected, in most it is not, and the water is therefore open to pollution of every description. In some instances the furrow or piping is used to supply secondary reservoirs or dams, from which the supply is distributed. These reservoirs are not well reported on.

(*d*) From dams or pans. In the more arid districts these form the only sources of supply to the smaller towns, villages, or farms. On the march across the Orange River Colony to Bloemfontein these were at times the only sources of supply. In some cases these dams are filled by furrows from a stream; in most instances they are formed in a slight hollow in the ground to catch and retain the rainfall, which in these cases is the only source from which they are filled. Here, of course, the supply diminishes steadily by use and evaporation during the dry season. These dams are also used for watering stock. In Cape Colony there are, in the Western Provinces, a good many large reservoirs, some, as in the Verkeerde Vale reservoir (near Touws River Station) largely fed by springs, others from the smaller streams and rivers. On the Stormberg plateau there are a large number of dams and reservoirs (see Sir W. Willcocks' report). These reservoirs are all primarily intended for agricultural purposes, but sources of this type were perforce used for drinking water during the war.

(2) *Well Water.* — Shallow wells form a common source of supply in all the colonies and are almost without exception unprotected. Those in Bloemfontein and Kroonstadt have been referred to; there were also some wells in Pretoria. All were open to contamination, and some invited it. Many of these are quite shallow, and open to soakage as well as to pollution from matters washed into them (*vide* Public Health Reports, Cape Colony).

As regards deep wells, Sir W. Willcocks points out that the extraordinary success which has attended deep bores in south-western Queensland cannot be expected in Cape Colony, as "the subsoil water can only be very local and insignificant in quantity." He gives the result of the boring operations conducted by the Cape Colony Government since 1890 to the end of 1898 "approximately as follows":—

"Number of holes bored, 2,600.

"Successful, about five-sixths.

"Unsuccessful, about one-sixth.

"Cost of boring—per hole, £17.

"Average depth of hole, 60 feet.

"Total discharge of water, 26 cubic feet per second.

"Discharge per hole, ¾ cubic foot *per minute* (equal to about 6,732 gallons in twenty-four hours).

"Practically all the holes need machinery of some kind to lift the water."

No information is given as to the time taken to put down these bore-holes—an important point in military work.

A few bore-holes have been made in Cape Colony for the supply of drinking water, and have apparently been satisfactory. Three old (disused) bores on the commonage at Bloemfontein were opened out after our arrival there, and gave a good supply. More use has been made of similar bore-holes in recent years.

(3) *Springs.*—Springs are not uncommon as a partial supply. In some cases the water is conveyed from them by pipes or in open furrows. In most cases there is no protection against pollution. The very excellent municipal supply in Pretoria is conveyed in pipes from springs a short distance outside the town, and distributed throughout the town.

(4) *Rain Water.*—Rain water collected from the roofs of the houses and stored in tanks is not an uncommon supply. In a few instances this forms the only source of supply (such as at Bathurst).

In most cases the total supply of a town comes from more than one source—*i.e.*, wells may supplement the supply conveyed from a distance (as in Bloemfontein, Kroonstadt, and Pretoria). Rain water is in Cape Colony not an infrequent addition to other supplies.

The Public Health Reports, Cape Colony, confirm our experience that the necessity for the provision of a pure supply, or the adequate protection of that supply when obtained, was not recognised by the local authorities, in spite of the strong recommendations of the district surgeons.

The persistent and continuous pollution of the soil in every inhabited area (which will be referred to in detail later) must be borne in mind in relation to every water supply, except from rain, deep wells, or efficiently protected areas.

4. Centres of Population.—Unlike the Kaffir Kraal, established on a height for security, the Dutch towns are invariably placed along the stream at the bottom of a valley. Each town is surrounded by a circle of townships and farms, the density of population diminishing towards the circumference of the circle. Hence between the areas influenced by the proximity of markets

and stores are areas that are very sparsely inhabited, at least by the white population. There is a tendency to speak of these areas as virgin soil, and to assume that such disease as appeared among the troops working in these areas must have been introduced by them. Both assumptions appear to be ill-founded. There is a comparatively large native population scattered over these areas; the Kaffir is a great traveller, and the whole country is seamed with native paths leading from larger centres to the kraals, or from kraal to kraal. The importance of this lies in the probability of the extensive spread of contagion by natives returning home from the mines, a factor which had received some attention before the outbreak of the War.

The older towns are built on a good plan. Parallel streets intersect a second set at right angles, and the town ends on a definite line of demarcation between town and veldt. The recent towns have barely escaped from the mushroom stage; their plan is the result, not of a definite intention, but of a process of accretion, and there is no uniformity in the type of buildings. A third type indeed is formed by the combination of the old town with modern excrescences. Only one feature was common to all —the absence of any definite sanitary system, including in this a satisfactory water supply as well as an efficient method for the disposal of excreta and slops. The principal sanitary defects are[1]:—

(*a*) The want of a pure water supply, as mentioned above.

(*b*) Imperfect methods for the disposal of excreta. There are practically only two methods in use—the old cesspool and the tub system.

Cesspools are far from uncommon; in some instances they are apparently considered less harmful because "the soil is very porous." This is not an advantage where shallow wells are used, or indeed surface water from any source. There are many varieties of the tub system. In a few instances there is a complete system: the tubs are removed under municipal arrangements and the night soil is carted away and buried outside, at some distance from the town. In other instances the night soil is thrown into a sluit outside the town, resulting in pollution of some stream sooner or later. In other instances the removal is not paid for by a sanitary rate, but by a charge for each occasion. This tends to infrequent removals. Again, in other cases no municipal arrangement for removal exists; it is carried out by private contract. In some cases the night soil is buried close to the town, or even in gardens.

In one case at least it is only within recent years that a privy

[1] Public Health Reports, Cape Colony, 1896.

has been held by the municipality to be a necessity for each house, and for some time after that, though erected, many of these privies remained unused, especially by the "poor white."

The common faults are: Tubs emptied at too long intervals; spilling of the contents; tubs rarely, if ever, cleaned or tarred; and great laxity in the methods of disposal of the night soil.

Special precautions as regards infectious excreta are almost unknown.

(*c*) Absence of latrine accommodation for the native population.

There is a large native population in every town or village, partly employed as household servants or grooms—that is, in some capacity about the dwelling-houses of the white population—and partly as labourers of all classes. Some of these labourers are accommodated in the yards of the places in which they are employed, but a large population live in the native quarter, or, in many cases, in a special native location. Latrine accommodation for household servants on the premises is practically unknown; they have to go elsewhere. But in the towns public latrines for natives are not common and are in no way sufficient, nor so situated as to be within easy distance from all the houses; while, on the other hand, the native prefers the open air. In the native locations, too, accommodation is very deficient and usually entirely absent.

The site of every town is seamed with water channels, the result of the excessive rainfall concentrated during a short period of the year. Many of these are dry during the season of minimum rainfall. These channels are habitually used by the native population as latrines, while rubbish and garbage, and in some cases, as mentioned above, night soil, are deposited in them.

(*d*) Slop water.

There are practically only two methods of disposal: by the surface drains, or on the ground in the vicinity of the houses. In some few instances, if the householder provides a receptacle at his own expense, the local authority arranges for the emptying of the receptacle. Urine is, as a rule, disposed of like slop water proper; there is no doubt that much finds its way into the surface drains.

Every one of these imperfect methods tends to a constantly increasing pollution of the whole surface of the soil, and to the consequent contamination of all superficial sources of water supply. In addition, the constant presence of large numbers of cattle and horses tends to foul the unpaved and badly made streets.

The smaller the town or village, the worse is the sanitation, while the lowest depth is reached in the farm, where well, privy, and cattle-kraal are all closely placed together. On some farms it appears that no pretence at any sanitary convenience is made; the

open veldt suffices for all purposes, and probably in some ways this is really less harmful than a more elaborate arrangement. It is not possible to say that the conditions in the native kraals are worse than those in the small outlying villages or in the native locations, but they are no better.

The important point is that throughout the whole of South Africa, at least prior to the War, wherever there was a human being there also was a persistent source of pollution both of the soil and water.

The Public Health Reports, Cape Colony, give much interesting information on these points. No report appears to have been issued between 1896 and 1903. The following extract from the report of the Medical Officer of Health, Cape Colony (Dr. Gregory), for 1903 shows that these conditions are not being overlooked by the sanitary authorities, but the difficulties in the way of amendment are very great.

The conditions in Natal differed but little from those in Cape Colony, and, though no reports are available from the Orange Free State and Transvaal, there is no doubt that in these areas also similar conditions existed, so that although the written record is fullest as regards Cape Colony, it is possible to take that as exemplifying the whole.

Extract, Report of the Medical Officer of Health, Cape Colony, 1903, p. 5:—

"(2) General Sanitary Condition of the Colony.

"Printed with this report will be found the annual reports of district surgeons and urban local authorities of the Colony dealing with the health and sanitation of their respective districts during the past year.

"For many years it has been the custom to obtain these reports and to print them for presentation to Parliament, and I am of opinion that on the whole their preparation and publication serve in some degree to direct attention to sanitary defects, and to stimulate interest in sanitary improvement; yet I am bound to confess that they attract less notice than the importance of the subject they deal with deserves. Were they only read and digested by those responsible for the carrying out of local sanitation, much valuable knowledge would be obtained of local conditions and of the almost universal need that exists for their improvement.

"Indeed, a consideration of these reports shows how extensively many of the most fundamental matters of sanitation and the protection of the public health are neglected, chief among which are the protection of water supplies; the disposal of night soil, and

refuse; the control of native locations; the prevention of overcrowding; the sanitary regulation of buildings and dwellings; the supervision of slaughtering and the sale of food, and the suppression of infectious diseases.

"Although attention is usually paid to other matters of municipal concern, it is frequently to be noticed that questions of health and sanitation are neglected. I only know of two local authorities in the Colony which employ a medical officer devoting his whole time to the work of the district—namely, the Municipality of Cape Town and the Board of Health of Kimberley—and even the number of local authorities who retain the services of a medical officer in merely a consulting capacity are few and can be numbered on the fingers. In many cases where such officers are appointed their position is purely a nominal one and their advice is rarely sought, and, if sought, is frequently neglected. Until every urban local Authority has the advice of a competent medical officer of health and acts on that advice, it is scarcely likely that any great advance in the general sanitary condition of urban areas in the Colony will take place."

Foodstuffs, and particularly milk, are not protected from contamination in any way. Most of the market gardening is in the hands of Malays (near Capetown) or of Indians, whose methods of enrichment leave much to be desired. The milk supply is practically not under any control; milk is mainly sold by the bottle, and the empty bottles are washed anyhow and anywhere. The milk always contains a large amount of foreign matter.

B.—The Prevalence of Zymotic Disease.

Before the War there was no exact information as to the prevalence of disease in the civil population. Two things contributed to this: the imperfect system for the registration of the causes of death, and the absence of any notification of disease. In none of the colonies was a certificate from a qualified medical man necessary before the registration of a death. In a sparsely populated country such as South Africa, where many cases die (especially among the natives and the poor whites) without having had any medical attendance, it is not possible to make such a certificate obligatory, and even in the towns, many of the entries on the register of deaths are, like a very large number of those in the districts, filled up from information received from friends or relatives without any written statement from the medical attendant, if there was one. The consequence is that many of the causes of deaths are registered under general terms, while many in which the cause is described more specifically are equally unreliable. "Fever," or "fever and

diarrhœa," is incomplete as a diagnosis; on the other hand, numbers of deaths are shown as from "remittent fever" from districts in which malaria would appear to be unknown.

In the second place, notification of disease was non-existent. In Cape Colony a Public Health Act existed, but it appears to have been of limited application. In the Public Health Report for 1896 is a copy of the Colonial Secretary's Memorandum to District Magistrates, No. 43, dated November 30th, 1896, showing the nature of the reports required from district surgeons. Each report is to consist of two parts: part 1 to "deal with the general health and sanitation of the district," part 2 to consist of a series of tables, as follows:—

A. Return of zymotic disease.
B. ,, small-pox and amaas.
C. ,, expenditure incurred on the suppression of small-pox.
D. ,, public vaccination.
E. ,, cases under medical treatment under part 2 of the Contagious Diseases Prevention Act (1885).
F. ,, expenditure—under that Act.
G. ,, lepers.
H. ,, persons in receipt of pauper relief.

Of these, A, B, D, and E were to be prepared by the district surgeon, the others by the resident magistrate.

As regards Table A—return of zymotic diseases—the following diseases were to be included:—

Typhoid or enteric fever.
Diphtheria.
Membranous croup.
Diarrhœa and dysentery.
Influenza.
Scarlatina.
Measles.
German measles.
Chicken-pox.
Mumps.
Whooping-cough.
Epidemic cerebrospinal meningitis.
Epidemic pneumonia.
Puerperal fever.
"And the disease variously called 'Typho-malarial fever,' 'Cape fever,' or 'African typhus.'"

This is an extremely comprehensive list, but the value of the return is at once discounted by a note at the head of the form, which is as follows:—

"In the absence of any notification of disease, or of registration of deaths, these numbers can of course be only approximate, but the district surgeon is requested to obtain as complete information as it lies in his power to do."

Perusal of the individual reports shows how little practical value this procedure has. This memorandum also shows that the only expenditure admissible on public-health matters was on the two lines, prevention of small-pox and limitation of contagious disease,

and this agrees with one's impression that the public mind is intensely nervous about small-pox and similar disorders, while other diseases receive no attention at all. The threatened importation of plague into Natal in 1898 and the history of the epidemic in Cape Town in 1901 show the anxiety with which such diseases are regarded, in strong contrast to the *laisser-faire* with regard to the other zymotic diseases, not of rare, but of daily occurrence.

It is only just, however, to add that the district surgeons were in favour of compulsory notification of disease, and many of them write strongly on the fact that they had no power in public-health matters, and that their recommendations were ignored by the local authority. One gentleman (Carnarvon, 1896) points out that "as the law of the Colony is at present, the district surgeon is prevented from being a member of the respective Town Council." Another (Hay, 1896) states under "Public Health Duties": "(*e*) The pointing out of numerous 'abuses,' some of the most serious nature, as affecting the water supply, to the local authority, but nothing has been done, and, unfortunately, district surgeons are powerless;" and, further, "(8) There is great need for a good workable Public Health Act, which would give the central health authorities power to compel, where necessary, erring local authorities to do their duty. Until such an Act is on the Statute-book, local authorities—more especially in the case of small country towns, where local prejudices and influence rule the day—will do nothing, at least as far as my experience teaches me, generally falling into an apathetic state, usually about one month after they have been 'duly appointed and gazetted.' As far as this town is concerned, it would appear that, owing to some legal defect, the rules of the Village Management Board cannot be enforced, and, as far as I am aware, no steps have been taken to put matters on a better footing; and so we go on from bad to worse from year to year, each one being a law unto himself, and even the most elementary rules of sanitation not being observed. *Diarrhœa and other gastro-enteric affections are, from year to year, becoming more and more prevalent, and more and more of a fatal type.*[1] This, I have not the very least doubt, is in a very great measure due to the water supply being so grossly contaminated; what with open water-furrows, numerous cess-pits, and the dirty habits of many of the inhabitants, &c., &c., it would indeed be very strange if it were otherwise."

In Cape Colony a Public Health Act existed, but, as will be gathered from the above, of very limited scope. In Natal no Public Health Act was even on the Statute-book, district surgeons

[1] These words are not in italics in the original, but deserve special attention.

rendered annual reports, but on even more general lines than in Cape Colony.[1]

In some of the larger towns—Cape Town, Kimberley, Durban, Maritzburg, and possibly a few others—a medical officer of health for the city, and in Cape Colony also for the Colony, was appointed, but without those statutory powers which alone render such an appointment of any practical value. There were port medical officers at Cape Town, Durban, &c.

The result of such a system became evident when plague appeared in South Africa. The condition of Cape Town itself appears to have come as a surprise to the local authority (*British Medical Journal*, 1901, p. 786), a striking example of the deficiency of the sanitary sense in South Africa. And yet in Cape Town some effort had been made to ascertain the prevalence of such diseases as enteric fever and infantile diarrhœa, which are reported on in the Public Health Report for 1896. Some efforts had also been made to improve the more glaring defects; a drainage scheme of considerable magnitude was in progress, and an excellent water supply had been provided and was carefully watched.

The other coast ports were little, if at all, better in general condition, while the water supply of Cape Town is probably not equalled elsewhere.

Of the up-country towns, Kimberley appears to have been the only one in which a constant endeavour was made to maintain a satisfactory state of things. There was, however, much enteric fever there. Sanitary organisation in the Orange Free State and Transvaal was even less efficient. No Public Health Acts or other legal provision existed, and it does not appear that the district surgeons or their equivalents rendered any systematic reports.

But what information is available shows conclusively the constant presence among the white and coloured population of the four states concerned of enteric fever, dysentery, and—in Cape Colony—diphtheria.

The following extract from the report of the Medical Officer of Health, Cape Colony, for 1903 (Dr. Gregory) shows very well the importance of enteric fever there :—

"(6) Enteric Fever.

"Setting aside tuberculosis, probably enteric fever is the most serious of the diseases, due to specific organisms, that prevail in South Africa. This disease constitutes a veritable scourge in many

[1] A "Public Health Amendment Act" was promulgated in Cape Colony in 1897, but had not time to be of any use before the War.

parts of the Colony. To how large an extent it prevails it is difficult to say, inasmuch as, owing to defective notification, our records are incomplete, and, moreover, there is no doubt that large numbers of cases occur which are never diagnosed, or, indeed, ever come under observation.

"Enteric fever is essentially a disease of uncleanliness and bad sanitation, and its prevalence is therefore a forcible indication of the extent to which these matters are neglected in this Colony. During the year 1903 many outbreaks of typhoid occurred in many districts of the Colony, in fact in all with the exception of twenty; 1,785 cases were notified to the Medical Officer of Health, under the provisions of the 29th section of the Public Health Amendment Act. Of these, 1,131 were Europeans, and 654 coloured; this disproportion between Europeans and coloured clearly indicates that cases among the latter are not being reported.

"*Mortality from the Disease.*

"Unfortunately the statistics of deaths registered during the year 1903 are not yet available, but a consideration of those for the calendar year 1902 will equally serve the purpose of showing the extent to which this disease prevails in the Colony.

"During that year in the thirty-five chief towns of the Colony the population, calculated on the basis of the two last censuses, 1891 and 1904, was 388,875, of which 209,146 were Europeans, and 179,729 were natives and coloured.

"During the year 343 deaths from enteric occurred, 136 being among Europeans and 207 among coloured. These figures give a rate of mortality of 6·50 per 10,000 for Europeans, and 11·52 for coloured, or of 8·82 per 10,000 for all races.

"These figures may be compared with those obtaining in England and Wales, which during the decennial period 1881-1890, amounted in the case of all 'fevers' to 2·35 per 10,000, the mortality for enteric fever alone being only 1·96 per 10,000.

"Every case of enteric fever has its origin in some previous case of the disease, and the manner in which it is spread may be taken as being one or the other of the following:—

"(*a*) Contaminated water.

"(*b*) Contaminated milk.

"(*c*) Commensal infection of persons living in the same house, owing to want of care and cleanliness in dealing with the excreta and discharges from an infected person in the house.

"(*d*) From excreta and other infected matters conveyed by flies or dust.

"Of these methods of spread, probably that of polluted water is

the commonest. It is true that in this Colony we do not often see widespread outbreaks of the disease due to polluted water, but this may arise from the fact that in many communities a large percentage of the inhabitants have at some time of their lives suffered from this disease, so that a large portion of them must be more or less immunised against its invasion and able to withstand its attacks. For there are many places in the Colony which, although small communities, are practically never without cases of the disease."

Dr. Gregory gives particulars of two "typical outbreaks" of water-borne disease, and further examples may be found in the text of the reports from district surgeons.

There is little information regarding the prevalence in the Dutch Colonies, but Bloemfontein, Harrismith, and Johannesburg had become notorious on account of the prevalence of enteric fever, and it undoubtedly occurred to a considerable extent throughout both these colonies, while there is evidence of a considerable increase in prevalence during recent years. There is no evidence to show that the prevalence in the Dutch was in any degree less than in the English colonies, concerning which more information is available, while the conditions were similar. Johannesburg was credited with being the centre from which natives disseminated enteric fever and dysentery throughout South Africa, but the conditions were rather exceptional and cannot be taken as indicating the general state throughout the Transvaal.

The incidence of enteric fever and its death-rate in proportion to the population cannot be obtained. Inspection of the registers of deaths in some cases, and examination of the records of civil hospitals in others, show in these individual instances that the recorded incidence is smaller than might have been expected. But, as has been shown above, the registry of deaths is not to be depended on,[1] while hospital records deal only with a limited number of the cases that do occur.

But, after all, the important point in this connection is that a large number of cases of enteric fever did occur year after year in every district of the four colonies, and that the conditions were such as to produce a constant specific infection of the area in which the cases occurred, with a probability of wider dissemination of the contagion.

The comparison of the incidence of enteric fever in the Boer population with that among the English troops is a separate question—one of much interest from an academic standpoint, but to which only a partial answer can be given. Such imperfect information

[1] Tabulated statements of the number of cases in various towns are for this reason of very little value.

as we have suggests that the incidence of enteric fever before the War among the permanent inhabitants of South Africa, and probably especially among the Boers, was considerably less than among the English garrison. Probably this is a special case of what appears to be a general rule, that the recorded incidence among the inhabitants of a country in which enteric fever is endemic is less than among immigrants into that country. This rule may, of course, only be an expression of our ignorance regarding the actual incidence among the aforesaid inhabitants, in whom larval forms will usually escape observation.

But under war conditions the incidence among the Boers in the early stages of the War was much increased. Whether it equalled or even approached the incidence among our troops cannot be said. But there is no doubt that they suffered severely in their own laagers at Magersfontein, Paardeberg, and elsewhere, in places where, as a body, they were the first occupants of the ground.

At Magersfontein enteric fever appears to have broken out among the Boers about the same time that it appeared in the garrison at Kimberley and in Lord Methuen's force at Modder River, while a severe epidemic occurred among the prisoners at Simonstown (apparently the result of infection in the laager at Paardeberg), which was synchronous with the beginning of the epidemic in Bloemfontein. But at later periods the Boers appear to have suffered from enteric fever to a smaller extent than our troops. This was probably attributable to several factors: first, that those most susceptible were attacked in the earlier stages; secondly, that their reinforcements were almost entirely drawn from the South African colonies; and, lastly, that they were aggregated in smaller masses, and occupied the same positions for a much shorter time.

Except during these war periods dysentery (of a bacillary type) has not been of importance in the medical history of South Africa. It was, as a rule, mild and amenable to treatment, though differing from the acute dysentery of India, in that ipecacuanha had but little effect. Nor was it commonly followed by hepatic complications.

Malarial fevers are prevalent in the low coast-belt of Natal, the "Bushveldt" of the Northern Transvaal, and to a less extent in the Western Transvaal towards the Limpopo, in the De Kaap Valley at Barberton, and more particularly in the Krokodil Valley, especially at Komati Poort, where their extreme prevalence was to some extent due to the very unsatisfactory sanitary conditions prevailing there. Deaths from remittent fever or from "typho-malarial" fever are reported from various parts of Cape Colony. At Graaff Reinet in 1896 forty-five deaths were reported from remittent fever, which was said to be "epidemic as in other years."

It is important to note that no mention of enteric fever is made in this report. At East London "typho-malarial" fever is reported as common on the "West Bank." One is prepared to admit that an occasional death from malarial fever contracted elsewhere (Zululand, Portuguese East Africa, &c.) may occur, but there is absolutely no evidence that malarial fever exists anywhere in Cape Colony. One can only conclude that here, as elsewhere, the diagnosis of remittent fever has been made where the disease was enteric fever. In this connection an article in *The Journal of the American Medical Association* of January 9th, 1904, by Dr. J. S. Fulton, M.D., is most important as showing that the so-called mortality from malarial fever in the Southern States of America is in fact due to enteric fever.

Certain so-called "anomalous" forms of fever prevail throughout the country. These are variously named; "Typho-malarial fever," "Cape fever," and "South African typhus" are apparently taken as synonymous (*vide supra*). We have also "Kimberley fever," "camp fever," and, generally, "low fever." Some of the cases of Kimberley or camp fever would appear to be in fact Mediterranean fever, which has also been recognised at Phillipolis in the Orange River Colony (*vide* articles by Lieutenant-Colonel Birt in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS). "Typho-malarial" fever, it may be assumed, is invariably enteric fever, although not of a classical type. The others are in our nomenclature usually grouped under the unsatisfactory heading of "simple continued fever." No doubt they include many of the milder forms of enteric fever, and cases of paratyphoid, besides indeterminate febrile affections, some possibly of no specific origin. But it would appear that these forms of mild, usually non-fatal fevers offer a promising field for investigation.

Pneumonia is occasionally prevalent, and at times in epidemic form, especially on the higher veldt, as at Kimberley, where it was attributed to dust. One finds, however, that cases of "pneumo-typhoid" are reported from various centres, so that here again is a way in which the true incidence of enteric fever is obscured. Pneumonia has not been common among the garrison of South Africa, which, however, was stationed at lower altitudes than those in which this disease has usually been observed.

The important facts with regard to the sanitary condition of the area of operation during the late War are then:—

(1) The general sanitation of the whole area was extremely bad.

(2) Enteric fever and dysentery were endemic throughout the whole area.

C.—Climatic Conditions.

1. *Barometric Pressure.*—The variations in this due to meteorological conditions are slight, and need no remark. But the lowered pressure due to altitude was believed by many to have some influence on the health. The area of operations (except during the later period in Cape Colony) was over 3,000 feet above the sea level as a minimum, and indeed the greater part was over 4,000 feet, rising in the Eastern Transvaal at Belfast to over 5,000 feet above the sea. Even under peace conditions the high altitude was blamed, probably unjustly, as a cause of cardiac irritability, especially as combined with the stimulating effects of the climate (not forgetting other stimulants—alcohol and tea or coffee), and it was the habit of those dwellers on the high veldt who could afford it, to spend part at least of the hot season in the moister and more soothing climate of the coast of the Cape Peninsula, and the spring and autumn on the Natal coast. There was undoubtedly a good deal of cardiac irritability and of palpitation among the troops during our operations on the higher areas, but there were, in addition to the altitude, the fatigues and privations of war which cannot be separated from the effects of altitude.

2. *Temperature.*[1]—Away from the coast-belt the extreme temperatures, both annual and diurnal, vary considerably. In January, the hottest month, the isotherms form a wonderfully regular system of concentric ellipses, whose major axis is situated at a little more than 24° east longitude, inclined slightly from east to west. In this month the isotherm of 92·5° runs from the Vaal at 24° east longitude (its most southerly point) slightly to the west of Kimberley, and through the west of the Orange Free State and the Transvaal, The isotherm of 90° runs parallel to the former at a distance of about 100 miles, and the three following isotherms, those of 87·5°, 85·0°, and 82·5°, run also parallel, but at diminishing distances. Practically the whole of the area of operations, in the Transvaal and Orange Free State, northern Cape Colony, and northern Natal, is included between the January isotherms of 92·5° and 82·5°.

In February the isotherm of 92·5° has receded to the north, the distances between the next three isotherms have increased, while the isotherms further south have become more crowded together. But the general parallelism is maintained, while in the later months the diminution in temperature from the central area towards the coast becomes more irregular, though the narrow and fairly regular ellipse of the January isotherms is still represented by a flatter and

[1] From Dr. Buchan's maps in Bartholomew's Meteorological Atlas.

less regular elliptical formation whose major axis has shifted further east.

July is the coldest month; here the isotherm of 70·5° passes slightly to the south of Johannesburg, that of 70° to the north of Kroonstadt, and slopes gradually north-east to pass to the north of Komati Poort, while to the south of this line the temperature gradually falls, but irregularly, to the coast, where the lowest isotherm, that of 55°, cuts off the western coast provinces, including the Cape Peninsula, from the rest of the Colony.

Putting this more generally, the annual isotherm of 83·5° passes from a little to the north of Vryburg to a little to the south of Johannesburg, and from that point passes to the north-east, leaving Lydenburg outside it. The annual isotherm of 72·5° follows the Rogge Veldt and Nieuwveldt ranges eastward along the Winterberg to the Stormberg range, and thence sweeps north-east through the eastern provinces and Natal to the south of Maritzburg.

From the above general statement it will be seen that the average temperature over the area in which the troops were working was sufficiently elevated to render active operations somewhat arduous during the hot season. Further, there is very little cloud, and the actual sun heat is considerably in excess of that represented by the figures quoted above. This of course applies most strongly to the upland continental climate, where the sudden fall of temperature after sunset is very marked, especially during the cold season, and the intermediate stages between it and the beginning or end of the hot weather. Unless some precaution in the way of additional clothing is possible, this sudden change is likely to give rise to a chill.

On the open veldt there is usually some little breeze which tempers the heat, but in the valleys, especially during the rainy season, the heat is oppressive, and the fall of temperature at night much less marked. In Pretoria, the difference even of 200 feet between the town and the hospital camp on the veldt to the east made an appreciable difference in the temperature.

3. *Wind and Dust.*—Even the strongest advocates of South Africa as the health resort for each and every disease confess that the dust is a great objection. In the cold season anti-cyclonic conditions prevail over the high ground of the Orange River Colony and Transvaal, and the winds are gentle and without much lifting power. Hence the dust is mainly that due to traffic, which is carried up slowly into the air to form a persistent haze, but does not travel far. In the hot season the opposite is the case: the prevailing barometric pressure is lower over the higher areas, the weather is less settled, and the wind tends to blow in gusts, and at an angle with the ground. The result is that every place where the surface

of the soil is soft and loose supplies its quantum of dust, and in a really good dust-storm comparatively large particles of grit are carried with sufficient force to be felt unpleasantly on the face and neck. The distance to which the smaller particles may be carried is probably considerable, but such a storm is usually followed by rain, which clears the air, so that the effective radius of a dust-storm for the conveyance of infective material must be influenced by the violence of the wind and the angle it makes with the ground, together with the interval between its passage over the infected area and the time when the rain falls at any other place in its onward track, which is somewhat cyclonic.

4. *Rainfall.*—The Cape of Good Hope Meteorological Commission Report for 1897 contains a very full discussion of the rainfall of South Africa between 1885 and 1894 by Dr. Alexander Buchan, M.A., LL.D., F.R.S.E., and a map by Mr. Struben showing the distribution of the summer and winter rains, besides a series of diagrams showing the distribution of the rainfall throughout the year in representative districts, mainly of Cape Colony.

It is sufficient to indicate generally the amounts of the total annual rainfall over the area of operations. To the east of a sinuous line running from near Grahamstown through Cradock and to the east of Colesberg to Kimberley and Vryburg, the annual rainfall is over 20 inches. A second more strongly curved line encircling the south-western border of Basutoland, sweeping through the Orange River Colony about midway between Bloemfontein and Ladybrand, Kroonstadt and Harrismith, turns to the west of Johannesburg, and thence passes at a sharp angle to the eastward between Johannesburg and Pretoria. To the east of this line the annual rainfall is between 30 and 40 inches; that is, over the greater part of the theatre of war the rainfall was at least 30 inches per annum.

In connection with this, the seasonal distribution has to be taken into account. Turning to Mr. Struben's map, we find that the line along which the rainfall during the summer months, October to March, is approximately equal to that of the winter months, April to September, runs from near Ladismith, Cape Colony, northwards as far as Fraserburg and then turns north-west. From the same starting point, it runs almost due east to reach the coast north of Port Elizabeth. To the north and east of this line the proportion of rain that falls during the summer is greater than that during the winter; to the south and west the converse occurs. A line of the same general shape with its angle about Fraserburg Road Station marks off an area to the north and east in which over 70 per cent. of the total annual rainfall occurs during the summer months, and it was in this area that our troops were mainly employed.

CHAPTER IV.

The Composition of the Army in South Africa.

Table A,[1] compiled from the Appendices to the Report of the Royal War Commission, shows the sources from which the Army in South Africa was derived and maintained.

Excluding the South African Colonials, whose numbers are uncertain, a total of 370,983 men were sent to South Africa, in addition to the original garrison (on August 1st, 1899) of 9,622 men.

It is impossible to distinguish accurately between the "seasoned" and "unseasoned" troops composing this force, but grouping them on broad lines, the following is probably the order of *increasing* susceptibility to epidemic disease of the components of the Army in South Africa:—

(1) Regulars and Volunteers from India.

(2) Colonial Contingents and S.A.C. from Canada: garrison, South Africa.

(3) Regulars from the Colonies.

(4) Militia from the Colonies.

(5) Regular units from home to December 31st, 1900.

(6) Regular units from home after December 31st, 1900.

(7) Drafts of Regulars
Militia Units and Drafts
Imperial Yeomanry
Volunteers
Scottish Horse
S.A.C.
} from home.

There may be some difference of opinion as to the exact sequence of the first six items, but the important point appears to be that the sources shown under (7) furnished a total of 205,803 men, or more than half (55 per cent.) of the total number sent to the country, and whatever opinion may be held as to the relative susceptibility of the other groups, there is no doubt that this large proportion of the total strength was almost entirely without any acquired immunity against climatic disease. The only point of uncertainty here appears to be as to the number of men sent out as

[1] *Vide* Appendix.

"drafts," who had previously been in the country and returned to it after having been invalided home, often on account of enteric fever.

The first year of the War, that is, up to the end of December, 1900, is the most interesting and difficult in respect of the composition of the force. Of 238,877 N.C.O.'s and men (including the garrison on August 1st, 1899) sent to South Africa up to December 31st, 1900, 171,702 went out with formed units and 67,175 with drafts (*vide* Appendix, Table B).

Of the 171,702 who went out as formed units, 122,898 were regulars, and of these 42,957 belonged to the Army Reserve. Of the 67,175 who went out in drafts, 62,325 were regulars, and of these at least 18,414[1] belonged to the Army Reserve, while 13,014 belonged to the Militia Reserve. Thus there was during this period a considerable leaven of older men (35 per cent. excluding the Militia Reserve) less liable to epidemic disease. The supply of Reservists ceased in September, 1900.

Up to the end of 1900 the main features were—the preponderance of the trained soldiers of the Regular Army (including many Reserve men) sent out in formed units; the addition of a large number of Militia (18,413 for the Lines of Communication) and of a large number of Imperial Yeomanry and of Volunteers of a good stamp.

As regards the Regular Forces, the drafts for the Cavalry and Artillery were generally of the normal composition as to age and service. For the Infantry, in addition to the normally qualified drafts, some immature soldiers were sent (between May and June, 1900) for duty with Militia on the Lines of Communication.[2] The minimum qualification for these "immature" men was three months' service and 18 years of age. For the other drafts the standard, "with a very few exceptions," was one year's service and 20 years of age, but about October, 1900, the service qualification was reduced to nine months, at least for some battalions. During the second year, "as the War appeared to be nearing a close," all available men irrespective of age, but over six months' service, belonging to reserve squadrons and depôts of Cavalry regiments, which would be detained in South Africa on the termination of the War, were sent out. Similarly for the Infantry, all "details" of regiments which were to remain in South Africa were sent out. It was stipulated in both these cases that these men, unqualified by age and service, were to be kept back from the front.

[1] Cavalry, Infantry and Artillery only, *vide* p. 87, Appendices, Royal War Commission.

[2] *Vide* p. 84, Appendix No. 5, Royal War Commission.

In January, 1901, it was decided to send out all available Cavalry soldiers, and in some cases the age qualification was reduced to 19½ years. No Infantry drafts were sent out during the first four months of 1901, but some sent in May included a certain number of mobilised reservists. In June the sending out of drafts was resumed, the age qualification being raised to 20 years.

In November, 1901, all available Cavalry soldiers were sent out. In April, 1902, the age qualification for both Cavalry and Infantry was again reduced to 19.

Shortly after the War had lasted a year "the only available drafts were the men who, month by month, attained maturity, or those who had been invalided home and had recovered."[1] But "maturity," as shown above, varied from time to time, according to the needs of the Army.

The average annual intake of recruits for each Cavalry regiment in South Africa during the three years of the War was about 200. It was considerably less for the Infantry.

The Reserves were exhausted by the end of the first year of the War, and the wastage had to be made good by recruits as they attained a minimum standard, which, never high, was at times dangerously low. The year between 19 and 20 makes a great difference in the stamina of the young soldier. On the other hand, it should be pointed out that the number of recruits in the older age groups was greater during the War than in normal periods; older men were enlisting, so that the proportion of those who barely reached the minimum standard was smaller during the War than would have been the case under normal recruiting conditions.

As regards the physical condition[2] of the men of the Regular Army, the Cavalry and Artillery appear to have been good throughout. As to the Infantry, the average physique of the regiments was good when they first arrived in South Africa; this was in great measure due to the large proportion of Reservists that they contained. Later on, the physique of the drafts was not satisfactory, partly owing to their youth, but also to some extent owing to indifferent material.

There seems to be little doubt that the minimum qualification of 20 years of age and one year's service should invariably be insisted on. Of the two, the period of service would almost appear to be the more important, certainly at least as regards town-bred recruits. The good and sufficient food with healthy surroundings and regular exercise, quite apart from the moral influence of the soldier's life, make a vast difference in the physical condition

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[1] Appendix 5, Royal War Commission, p. 86.

[2] *Vide* p. 41, Report of Royal War Commission.

between the recruit on joining and the (partially) trained soldier of a year's service.

The Militia were, generally speaking, inferior to the Line. This was partly owing to the lower age limit—18 years of age. It was at first proposed to make the age limit 19, but this difference of a year would have made one-third of the men unavailable.[1]

The Imperial Yeomanry went out in three contingents, the first, of about 10,000 men, early in 1900, the second, about 17,000, in the spring of 1901, and the third, about 7,000, in the winter of 1901-02.[2]

The age limits and physical standards were the same in all, 20 to 35 years of age, and the measurements of the Regular Forces, the only relaxation as regards the medical examination being that, in relation to the short term of their engagement, it was "sufficient that the candidate should be free from organic disease or other defect likely to prevent him doing his work during the duration of the present War."[3]

The physique of the first contingent was "excellent and far above that of the Regular Army." The second contingent were not so satisfactory in this respect: their examination was not carried out by the regular recruiting medical officers,[4] and the third contingent contained a proportion of physically inefficient men, who should never have enlisted.

The age qualifications for the Volunteers were the same as for the Imperial Yeomanry, and here too the same variation in the quality of the men was observed as in the Imperial Yeomanry (and indeed in the drafts for the Regulars); as time went on the proportion of inefficients who were sent out steadily increased in all three bodies.

As regards the Colonial troops: the over-sea Colonials and the earlier regiments of South African Colonials were good. Later on a large proportion of the men enlisted in the South African Irregular Forces were physically unfit for service, and only blocked the hospitals.[5]

Under the ordinary conditions of military service during peace, a constant process of elimination of the less fit is going on; the greater incidence of disease of all kinds on the young soldier in the earlier years of his service is of course familiar. Abroad, this process is accelerated by climatic disease, in which one may, for

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[1] Report of Royal War Commission, p. 63.

[2] *Ibid.*, pp. 70, &c.

[3] Special Army Order, dated January 2nd, 1900.

[4] R.W.C., vol. i., 5384.

[5] *Vide* also Report on the Medical Arrangements, South African War, pp. 209 and 210.

convenience of designation, include enteric fever and dysentery, During war, this elimination is more rapid owing to the greater stress and the more frequent opportunities for infection, but heretofore our armies in the field have been composed mainly of units from which the greater proportion of the unfit have been weeded by natural processes, and who were at least familiar with the ordinary details of camp-life, and accustomed to the restrictions necessitated by a life in common. In the late War, the conditions were very different : over half the field force was composed of the raw material of an army ; in it no natural selection had taken place ; the individuals of which it was composed were without knowledge of a mode of life independent of civilisation, and in many cases impatient of restrictions, beneficial to themselves and their fellows, whose purport they did not understand.

Hence it followed that the natural process of elimination, which normally spreads over the first lustrum, accelerated by fatigue and privation, by exposure to a widespread infection, was compressed into the shorter period during which each body remained in the country. Such must be the case in all campaigns, but in none of which we have any experience has the proportion of the raw material to the finished article been so great. This difference must be remembered in considering the incidence of disease, and comparing it with that found in other campaigns.

The Sanitary Organisation.

(1) *The Personnel.* — The system in vogue at the beginning of the War, and indeed during the whole period, provided every Commanding Officer, of whatever degree, with a sanitary adviser, and the chain of responsibility in sanitary matters ascended by links similar to those in command. But, as has been pointed out already, the initiative of the officers of the medical service was limited to recommendations ; they had no executive powers, which was fortunate in one way, as they possessed no staff to carry out their wishes. The only *personnel* provided for sanitary work was, so far as smaller matters were concerned, the regimental pioneers and their fatigue parties, while for more extensive operations the aid of the Royal Engineers had to be invoked. There was no general scheme for the purification of water, although in individual units arrangements were made which acted well. The sanitary duties of the various officers, according to their degree, were laid down in detail in the Regulations for the Army Medical Services for 1897 and 1900, which together covered the whole period of the War. Many of these duties, in the case of administrative officers, were carried out by deputy, but the final

responsibility rested with the administrative officer, forming an important addition to his already onerous task, and rendering it impossible for him to supervise both sides of his work in detail. Much of his work had, of necessity, to take priority; movements of troops, arrangements for the medical attendance of sick and the provision of accommodation for them, of *personnel*, medical and nursing, are all duties which come directly under the public eye. Preventive medicine is not so obvious in its immediate results and hence when time only permits of one portion of the work being done, that portion of which the result can be seen by the least instructed is the more likely to be carried out, for no measures which may diminish future sickness will counterbalance any apparent neglect to provide for the immediate comfort of those who have already fallen sick. The obvious remedy is to remove this responsibility for details on the sanitary side from the administrative medical officers, which has now been done.

Further, many of the duties assigned by these regulations to the Principal Medical Officer of a division cannot be carried out in the field, for the very sufficient reason that the occupation of towns, of villages, of certain sites for camps, the discrimination between various sources of water supply and the like, are all matters so much dependent not only on the movements of our own troops, but on those of the enemy, that military necessities often render the occupation of certain places incumbent, whatever their sanitary defects. No doubt the words "military necessity" have in the past been used to cover want of foresight, errors in judgment or even absolute neglect of precautions that might have been taken, but even with this proviso, the fact remains that field sanitation must always be very much subject to the chances of war, as much determined by the enemy as by ourselves, and its area must be limited by the line of contact with the enemy.

It says much for the knowledge, energy and influence of the officers of the medical service that in the past a system so fragmentary and incomplete should have attained the excellent results which it did. But the magnitude of the operations in South Africa, their duration, and above all the small proportion of the trained officers of the medical service, showed distinctly that such a system must be replaced by one more suited to modern requirements, where a certain *personnel* of all ranks of the medical service is definitely detailed for sanitary duties, and where every individual in the field, as far as he can, assists in the maintenance of proper conditions.

(2) *Equipment:* (i.) *Regimental.*—The ordinary ordnance equipment of a unit included all the implements necessary for the pioneer work of the unit, including the making of latrine trenches, &c., and also a number of camp kettles for cooking, which served for boiling

the drinking water also when fuel was available. In the later stages of the War additional camp kettles were issued for this specific purpose.

(ii.) *For the Supply of Water: (a) Water-carts.*—According to "War Establishments, 1898," water-carts were only allotted to the various supply columns of the Army Service Corps, and to the Bearer Companies and Field Hospitals, on the following scale; none were allotted to units :—

	No.
Cavalry Brigade Supply Column	1
Infantry Brigade Supply Column	3
Divisional Supply Column	2
Corps Troops Supply Column	2
Bearer Company	1
Field Hospital	1

giving the following totals for—

Cavalry Brigade	3
Infantry Brigade	5
Infantry Division	13
Army Corps	50

The following note is made concerning these water-carts: "A 5. Water-carts, forming part of the establishment of supply columns, are intended for general use. They will be distributed according to the orders of the General Officer Commanding. For campaigns in hot countries, the number of water-carts will be increased if considered necessary."

The number authorised at the onset of the South African War is given in the "Organisation and Details of Transport," Capetown, 1899, which includes the following preliminary note on p. 5 :—

"(vii.) Water-carts.—Although water-carts have been allotted to different units it must be understood that they are available for general use in brigades, &c., as the General Officer in Command may direct."

The following is the scale then authorised :—

	No.
Cavalry Regiment	1
,, ,, Headquarters with Corps Troops	1
Ammunition Column, Corps Troops	2
,, ,, others	1
Royal Engineers, Field Company	1
,, ,, Field Troop	1
Mounted Infantry, Staff	1
Infantry Battalion	1
Army Service Corps Company, Corps Troops	2
Supply Columns, Divisional	2
,, ,, Cavalry Brigade	1
,, ,, Infantry Brigade	3
,, ,, Auxiliary, L. of C.	4
,, ,, Supply Park	2
Field Hospital, Corps Troops and Brigades	2
,, ,, others	1
Bearer Company	1

On the reorganisation of the transport, a new system was introduced (Army Order 4, of January 24th, 1900), and the new scale was authorised in Army Order 2, of January 29th, 1900, as follows :—

	No.
Each Cavalry Regiment	1
Each Ammunition Column	1
Mounted Infantry, each Regiment, or Colonials or Imperial Yeomanry, four Companies or Squadrons	1
Royal Engineers, Bridging Troop	1
Field Troop	1
Field Company	1
Infantry, each battalion	2
Bearer Company	2
Field Hospital	2
Supply Column	2

This scale remained in force till the end of the War, though the actual numbers provided varied with the local circumstances from time to time.

(*b*) *Water Equipment of the Royal Engineers.*—This is given in Table 15, Equipment Regulations, Part II., Section 10, Engineer Details, as follows :—

	No.
Troughs, water-proof, 600 gallons, Field Troop	3
,, ,, ,, ,, Field Park	6
Pumps, lift and force (to 60 feet), Field Troop	1
,, ,, ,, ,, Field Park	2
,, Tripod, Field Troop	3
,, ,, Field Park	3
,, ,, Field Company	1
Wells, 1¼ inch, Bridging Battalion	1
,, ,, Field Park	4
,, apparatus, driving, Bridging Battalion	1
,, ,, ,, Field Park	2

In addition to this, the regulation equipment, a large quantity of material and machinery for use in connection with water supply was sent out from England in October, 1899, and further supplies were despatched throughout the campaign.[1]

The "well, 1¼ inch," is the "Norton tube well," and is designed to obtain water from a moderate depth. With an ordinary lift pump, it is applicable where the water level is not more than 28 feet from the surface; with the deep well pump and working barrel, it is applicable where the water level is not more than 80 feet from the surface. These wells cannot be driven through rock or large stones, but they have been driven through chalk and very hard beds of flint and gravel. Five men are required to drive the well quickly, and the rate of progress varies from 12 feet per

[1] *Vide* Appendices of the Report of the Royal War Commission, pp. 206 to 209.

hour in flinty chalk to 20 feet per hour in soft soil. The yield with a suction pump in good condition is up to ten gallons per minute from a depth of from 20 to 28 feet. But they are only effective where there is a good flow of water from the outside into the lower end of the pump; where the strata are very porous, *e.g.*, in gravel and some sorts of chalk where water flows freely, the yield may be up to the capacity of the pump as given above, but in other soils, such as sandy loam, there may not be enough to supply the pump.

The conditions in the area of operations were not favourable to the success of these appliances; the soil and subjacent strata are not suited for them, and the water is frequently at a lower level than that at which the pump is designed to work, or indeed at which a simple pump can work at such high altitudes.

A good deal was said about the neglect to put down boreholes at Paardeberg and elsewhere. Some boreholes had been made on the western line before this, and many were put down at later periods; all that need be said here is that the process is a long one, and the result, both immediate and remote, somewhat problematical.

(*c*) *Filters.*—Filters have not formed a part of the normal equipment of a regimental unit on field service, mainly on account of the difficulty of obtaining a good pattern. Various patterns have been issued at different times, but none have been satisfactory. For the late War it was proposed to issue the "Berkefeld" filter, one to each company or similar unit of 100 men. Owing to difficulties in the supply of the large number required, this standard could not be maintained and many of the regimental and other units landed without these filters. The supply was increased later, and in addition a similar filter of a somewhat different pattern (Messrs. Slack and Brownlow's) was issued to some units. The practical employment of these filters will be dealt with later.

(iii.) *Disinfectants.*[1] — The following were held on charge by the Army Service Corps for issue "when available and certified as necessary."

"For every 1,000 British troops per day :—

Carbolic acid powder	lb. $\frac{1}{3}$
Chloride of lime	lbs. 2
McDougall's disinfectant powder	lb. 1
Izal	gallon $\frac{1}{2}$

"Medical officers will be careful to adhere to these scales as far as possible."[2]

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[1] P. 385, Report on the Medical Arrangements.

[2] Army Standing Orders, with Army Order 4 of November 6th, 1899, and continued to April 1st, 1902.

In addition the Army Service Corps obtained perchloride of mercury or crude carbolic acid for disinfecting purposes when required.

These supplies were almost always available in sufficient quantity.

(iv.) *Hospital.*—Two Thresh's steam disinfectors were sent out at the beginning of the campaign (in November, 1899), of which one was destined for No. 1 General Hospital at Wynberg, while the other was sent to Natal. The number of these was steadily increased during the campaign, when each general hospital (and most of the stationary hospitals) was provided with one.

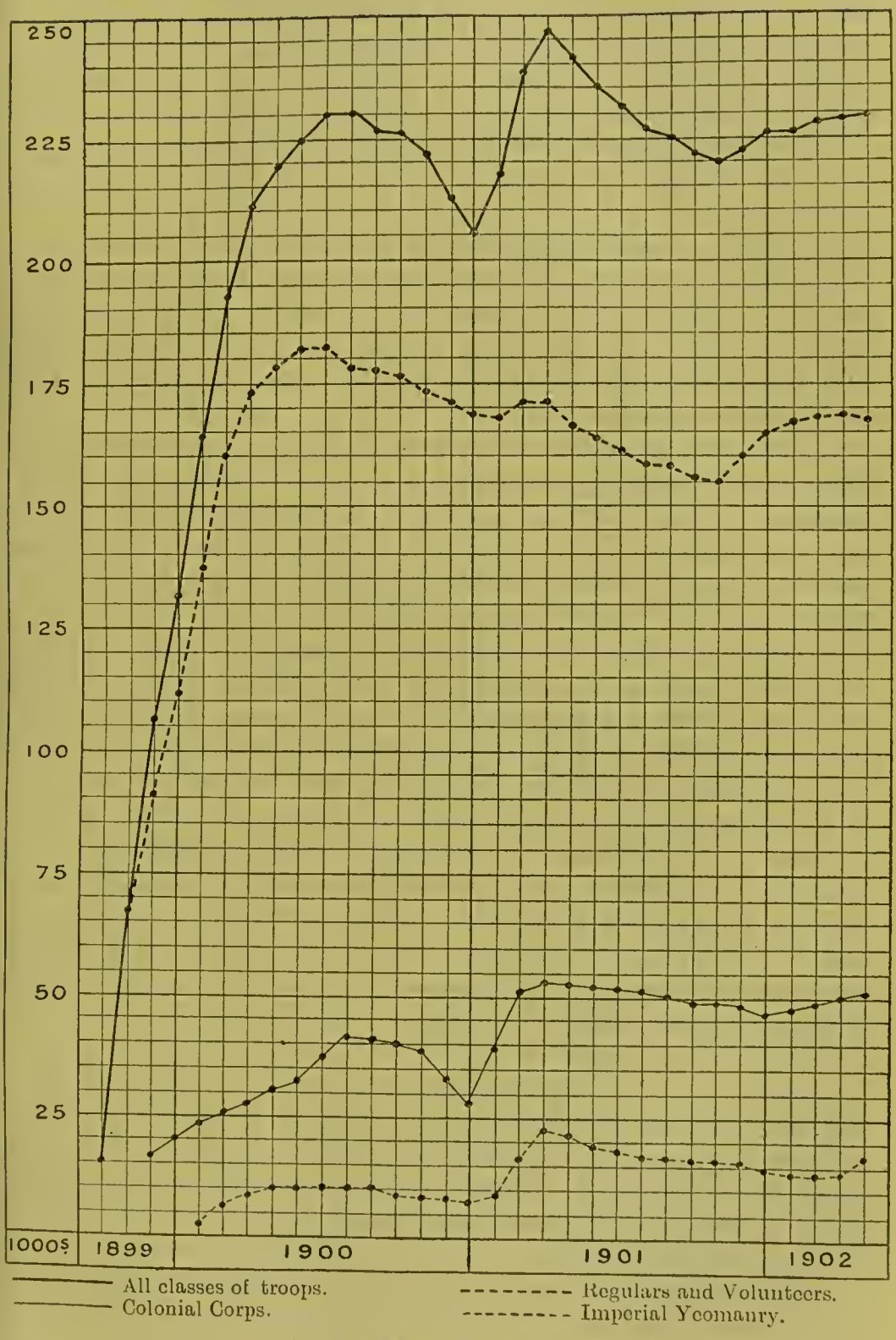
(v.) These details refer only to the organisation and equipment of the field force as despatched from England.

CHAPTER V.

The General Results as regards the Incidence of Disease.

Before entering on any discussion of the incidence and varieties of disease, it may be advantageous to consider the variations in strength month by month in the whole Army and in its component parts. Details of the numbers embarked have already been given, and fig. 4 (which has been plotted from the mean of the strengths in every two consecutive months) shows how, after a steady increase to June—July, 1900, the monthly strength of Warrant and N.C.O.'s and men fluctuated considerably about a high average. The important points appear to be, first, that the strength of the Regulars and Volunteers, always the predominating element, fell on the whole steadily from June—July, 1900, to October—November, 1901, when it increased again to the end of the campaign. The sudden increase in the total strength between January and April, 1901, was due to the arrival of the 2nd contingent Imperial Yeomanry and of Colonial Corps.

Wastage.—It is doubtful whether the records of strength are sufficiently accurate to admit of more than an approximation to the true wastage of an army, under the conditions to which it was exposed, but for purposes of comparison with other armies they appear to be of considerable use, as in all operations of any magnitude the statistical records can only be approximate. It has been possible to extract from the tables in Appendix 5 to the Report of the Royal Commission on the War in South Africa a series of numbers of men embarked at various periods. Then by comparing the totals embarked during a period with the strength in South Africa at the end of the period, the difference between the numbers to be accounted for and the strength actually present represents the sum of the loss between the port of embarkation and South Africa, and that in South Africa; and this, in relation to the mean strength during the period, gives the rate of wastage during that period, which, for convenience of comparison, is brought up to an annual rate per 1,000. These rates are, of course, only approximate. The numbers disembarked in South Africa must always have been less than those shown as embarked, probably by only a small amount, and there is also some



S. Africa Monthly Strengths.

FIG. 4.

difficulty in separating the arrivals at the beginning and end of each period, but as the strengths used are the mean between that in the month named and the following month, this difficulty is largely eliminated. The mean strength is the total of these monthly strengths divided by the length of the period in months.

The following results, which relate to the Warrant and N.C.O.'s. and men of the Regulars, Militia, and Volunteers, have been obtained :—

Period A : October 13th, 1899, *to December* 31st, 1899.—Total of troops in and embarked for South Africa, including drafts in January, 1900, 94,531. Strength December—January, 90,681. Wastage 3,850. Mean strength during the period, 68,579. Duration of period two and two-thirds months. Wastage 56·14, or 252·63 per 1,000 per annum.

Period B : January—June, 1900.—Troops embarked, 107,946. Strength June—July, 182,344. January—February, 112,064. Increase in strength during period, 70,280. Difference between troops embarked and increase in strength gives the wastage 37,666. Mean strength, 157,661. Duration of period six months. Wastage 238·94, or 477·88 per 1,000 per annum.

Period C : July—December, 1900.—Troops embarked, 15,143. Strength July—August, 182,034. December—January, 170,943. Decrease, 11,091. Deduct City Imperial Volunteers gone home, nett decrease 10,291. Sum of troops embarked and decrease in strength gives the wastage 25,434. Mean strength, 176,318. Duration of period six months. Wastage 144·25 or 288·5 per 1,000 per annum.

Period D : January — December, 1900.—Troops embarked, 123,089. Strength December—January, 1900-01, 170,943. January—February, 1900, 112,064. Increase 58,879. Add half City Imperial Volunteers, say 800. Total, 59,679. Difference between troops embarked and increase in strength gives the wastage 63,410. Mean strength, 166,990. Duration of period one year. Wastage 379·72 per 1,000 per annum.

Period E : In the whole force, all classes of troops, Warrant and N.C.O.'s and men for the whole period of the War.—Killed, 5,256.[1] Died, 15,614.[1] Invalided, 72,314.[1] Total wastage from deaths and invaliding, 93,184. Numbers exposed to risk during the war, 548,237. Wastage from deaths and invaliding alone per 1,000 per annum, 169·97.

These results are more interesting if compared with the mortality from all causes during the same periods, and with the proportion of wastage not due to death.

[1] P. 99, Appendix 5, Report of Royal War Commission.

Period	Ratio per 1,000 per annum: Wastage 1	Mortality 2	Remainder 3	Ratio of 3 : 1 4	Remarks
1899	252·63	60·89	191·74	75·90 %	Regulars, Militia, and Volunteers.
1st half, 1900 ..	477·88	76·53	401·35	83·98 ,,	
2nd ,, ,, ..	288·50	29·22	259·28	89·87 ,,	
1900	379·72	51·55	328·17	86·42 ,,	
Whole war ..	169·97	38·09	131·88	77·59 %	

The results in Column 1 of the above table show a wastage that is less than was anticipated, but the most evident feature, which is of course an obvious result, is the very material difference between the rates at different periods. The first half of the year 1900 was without doubt that in which the conditions were most severe: the relief of Ladysmith and Kimberley, the advance to Bloemfontein and Pretoria, the epidemics after the relief of Ladysmith, and in Bloemfontein and Kroonstadt, all fall within this period. The wastage in war is due to several causes: deaths, invaliding, prisoners, men discharged, corps disbanded or sent home. The last line in the table includes only losses by deaths or invaliding. The other lines include deaths and invaliding, prisoners and possibly some discharges; but the only unit which is known to have left the area of operations during the period, the City Imperial Volunteers, has been allowed for in the calculations. So that the last line is not comparable with the others; it is also probably the most accurate. Column 3, giving the wastage not due to deaths is useful, especially if taken in relation to the total loss. This relation is shown as a percentage of the total loss in Column 4. In the first period the wastage shown is somewhat in excess, as the strength includes drafts in January, 1900, which cannot be distinguished. Invaliding is the most important element in determining the total wastage, and Column 4 shows that it rose in the latter half of 1900 over the mean of the whole period as well as over the rate in the first half of the year, while it was considerably below the mean level in the war period of 1899.

On the outbreak of war, estimates of the probable wastage varied between 10 per cent. per mensem (Director of Military Intelligence) and 10 per cent. per quarter (Director-General, Army Medical Staff). These two estimates probably represented, on the one hand, the loss from all causes, and, on the other, that from deaths and invaliding. The latter estimate—10 per cent. per quarter—was accepted.[1] It appears from Column 1 that this estimate of 40 per cent. per annum was sufficient to cover the total wastage from all causes during the whole period of 1900, but insufficient for the

[1] Appendix 5, Report of Royal War Commission, pp. 81 and 89.

first half of the year. It was more than enough to make up for the wastage from *deaths and invaliding* over the whole period of the War.

The Total Inefficiency from Wastage and Men in Hospital.—Besides the wastage due to loss of men from the strength, there is also a temporary wastage due to the number of men in hospital. Our records of the admissions do not cover the whole of the sickness which occurred during the War. This deficiency is due to several causes: (*a*) The loss of the admission and discharge books from a considerable number of the smaller hospitals. Some of these losses occurred from the vicissitudes of the campaign, others in the transition stage after the end of the War; others, again, in transit. Such losses probably must always occur where so many different units are established, where some of these units are occupied only for broken periods, and where the duration of operations is so great. Some of these lost records covered a considerable period of time, and must have included numerous admissions; the remainder covered short periods and included smaller numbers. (*b*) Neither the sick nor wounded of the South African Constabulary nor of civilians employed were included in our records, though the deaths are included in the total deaths during the War. This is a comparatively small item.

We can obtain an approximate estimate of the deficiency through a comparison of the actual number of deaths with those recorded in our returns. Messrs. Schooling and Rusher, for the purpose of a paper on "The Mortality Experiences of the Imperial Forces during the War in South Africa," read before the Society of Actuaries, prepared a list of all deaths with very great care, from two official sources, in which all duplicate deaths were eliminated. Their total of deaths among the Warrant and N.C.O.'s and men of all classes of troops for the whole period of the War shows deaths from wounds, 6,872; from illness, 14,011; or a total of 20,883, as against 20,870 as given in Appendix 5, Royal War Commission, p. 99. They limit the term "wounds" to "those from wounds or on the battlefield," and "illness" to "those from other causes."

Our records show a total of 13,058 from all causes (which does not of course include those on the field), of which 1,709 were the result of wounds in action, leaving 11,349 comparable with the 14,011 of Messrs. Schooling and Rusher, showing a deficiency of 2,662 deaths which are not on our records, or 18·98 per cent. of the total deaths from other causes than wounds. It is probable that the deficiency in the records of sickness is not so great as this; most of the hospitals whose records are missing were comparatively small units from which sick were transferred, and probably in a good many instances the cases first came on record at a larger

hospital, while, on the other hand, the deaths were reported direct to a central authority. But one must assume that our records of sickness are deficient to the same extent as that of deaths, with the proviso that on making up the deficiency we probably obtain a maximum number of admissions.

The question of the strength on which to calculate the ratios is somewhat difficult, as there is a slight want of agreement between the various numbers given in the Appendices to the report of the Royal Commission. The method adopted by Messrs. Schooling and Rusher (trained actuaries), in the paper referred to above, has been followed, with some slight corrections in the numbers after revision of the schedules by the War Office. The "number exposed to risk" is, then, 548,237, including the Warrant and N.C.O.'s and men of all classes of troops. Using this as a basis, we get the ratios recorded in Column 2 of the following table. These have to be increased in the ratio of 14,011 : 11,349—*i.e.*, multiplied by 1·23455, to bring the total death-rate from our records to the true total death-rate from disease.

	Number	Per 1,000 per annum	
		Uncorrected rate	Corrected rate
Admissions	425,418	775·97	957·97
Deaths from other causes than wounds	11,349	20·70	25·58
Invalids	72,551	—	132·33
Constantly sick	12,748	23·25	28·70

The total wastage is, then, for the Warrant and N.C.O.'s and men of all classes of troops for the whole period of the War as follows: wastage from death and invaliding, 169·97[1]; inefficiency from admission to hospital, 28·70; or a total of 198·67 per 1,000 per annum, approximately 20 per cent. The mean hospital admission-rate, 958 per 1,000, was comparatively low. The constantly sick formed less than 3 per cent. of the strength, a rate which speaks for itself.

The following tables, compiled from our records with the correction spoken of above, show how the admission and death rates are made up :—

ADMISSIONS PER 1,000 OF STRENGTH, ALL CLASSES OF TROOPS, EXCLUDING OFFICERS.

Enteric fever	129·90	204·28	260·92	388·88
Simple continued fever	74·38			
Malarial fever	56·64			
Dysentery	85·81	127·96		
Diarrhœa	42·15			
Other diseases	454·19			454·19
All diseases	843·07			843·07
Wounds in action	47·95			114·90
Other causes not disease	66·95			
All causes	957·97			957·97

[1] See p. 49.

	Deaths per 1,000.			
Enteric fever	18·06	18·11	18·31	21·38
Simple continued fever	0·05			
Malarial fever	0·20			
Dysentery	3·02	3·07		
Diarrhœa	0·05			
Other diseases	3·20			3·20
All diseases	24·58			24·58
Wounds in action*	2·94			3·92
Other causes not disease	0·98			
All causes	28·50			28·50
Killed in action	9·59			9·59
Total Loss	38·09			38·09

* This ratio is calculated on the difference between the number shown as "deaths from wounds" (6,872) by Messrs. Schooling and Rusher, and the number shown as "killed in action" in Appendix 5, R.W.C., p. 99 (5,256). It differs from the numbers shown in our records, probably through differing interpretations of "killed in action" and "died out of hospital" in the case of wounds.

The case mortality per 100 admissions is important. Here the actual number of admissions and deaths which are recorded are given, and the calculations are based on the deaths in hospital only:—

Deaths per 100 Admissions.

Disease	Admissions	Deaths in hospital	Case mortality	Died out of hospital	Total
Enteric fever	57,684	8,020	13·90	2	8,022
Simple continued fever	33,033	23	0·07	—	23
Malarial fever	25,156	85	0·33	—	85
Dysentery	38,108	1,342	3·52	1	1,343
Diarrhœa	18,716	20	0·11	—	20
Other diseases	201,696	1,376	0·68	46	1,422
All diseases	374,393	10,866	2·90	49	10,915
Wounds in action	21,292	1,395*	6·55	314	1,709
Other causes, not disease	29,733	235	0·79	199	434
All causes	425,418	12,496	2·94	562	13,058

* See note to last table. These are the numbers recorded in our tables. In these tables, and in those to be given later, the heading, "Other causes, not disease," includes local and general injuries, poisons, poisoned wounds, "no appreciable disease," and deaths the causes of which were unknown.

The following particulars, not included above, may be useful for comparison: Proportion killed to wounded, 5,256 : 26,286[1] : : 1 : 5.

[1] These two numbers have been corrected from our records in the proportion mentioned above.

Admissions for wounds : admissions for disease, 21,292 : 374,393 : : 1 : 17·58. Deaths, wounded and killed : deaths from disease, 6,872 : 13,475[1] : : 1 : 1·96.

The following table is taken from an article by Mr. A. G. Mackenzie, in the *Transactions of the Actuarial Society of Edinburgh*, 1881, with additions from the experience of recent campaigns :—

Comparative Losses from Battle and Disease (Mackenzie).

Campaign	Loss per cent. battle	Proportion total losses	Loss per cent. disease	Proportion total loss	Total loss per 100
Crimean War—					
English per annum ..	3·3 ..	0·262 ..	9·3 ..	0·738 ..	12·6
French per annum ..	3·4 ..	0·219 ..	12·1 ..	0·781 ..	15·5
American War—					
North, 1st year	1·7 ..	0·254 ..	5·0 ..	0·746 ..	6·7
,, 4 years	3·9 ..	0·345 ..	7·4 ..	0·645 ..	11·2
Austro-Prussian War, 1866—					
Prussian losses, 6 weeks	1·4 ..	0·438 ..	1·8 ..	0·562 ..	3·2
Franco-Prussian War ..	3·2 ..	0·696 ..	1·4 ..	0·304 ..	4·6
Russo-Japanese War ..	(13·7) ..	0·80 ..	(4·1) ..	0·20 ..	(17·8)
S. African War	1·25 ..	0·330 ..	2·46 ..	0·670 ..	3·8

Notes.—The figures relating to the Franco-Prussian War are taken from Mr. Mackenzie's article, and are derived from "Die Verluste der Deutschen Armeen," by Dr. Engel, of the Royal Prussian Statistical Bureau. Those relating to the Russo-Japanese War are from a report by Colonel W. G. Macpherson, C.M.G., R.A.M.C., No. 16 of the Medical and Sanitary Reports of the Officers attached to the Japanese Army. The figures in brackets are calculated on an *estimated* mean strength of 250,000 for the period of the War. The *proportion* of total losses under the two headings is calculated from the actual number of deaths during the War, given in Tables 1 and 2 of the report mentioned. These have, therefore, a greater degree of accuracy.

It is to be noted that in this table the loss from disease includes what is shown in the detailed tables above as loss "from other causes not disease," which will be seen later to be not entirely negligible.

In Mackenzie's table (quoted above), and in others of similar import, stress is laid on the ratio of the loss by disease to that from battle. This is, of course, a legitimate comparison from some aspects, but it must not be diverted from its useful purpose and employed as a criterion of the excellence of the medical service engaged. Loss from battle is determined chiefly by the nature of the enemy's resistance ; it depends on the clash of large masses in pitched battles, assaults, and sieges for its magnitude ; it is more likely to be predominant in a short and sharp campaign than where there is a persistent resistance by numerous small bodies of the enemy. This ratio, of course, varies at different periods of one and the same campaign, *even while the death-rate from disease is declining*, as is well seen, for example, in the case of the losses among the Warrant and N.C.O.'s and men of the

Regulars and Volunteers during the South African War, as follows :—

Period	Proportion of total loss. Battle per cent.	Disease per cent.	Ratio	Disease loss per 1,000.
11.10.99 } 30.9.00 }	35·3	64·7	1 : 1·83	38·21
1.10.00 } 30.9.01 }	26·0	74·0	1 : 2·85	22·09
1.10.01 } 31.5.02 }	21·2	78·8	1 : 3·74	21·28

(Calculated from Messrs. Schooling and Rusher's Table IV., p. 27.)

The proportion of the total death-rate which is due to wounds received in action is, of course, also determined by the same conditions, but not always to the same extent. In the tables the admissions and deaths from wounds have been included, and their relative proportions shown, in order to complete the hospital records.

It seems interesting, and possibly important, to bring our results in the South African War into comparison with results in our previous campaigns in sub-tropical climates, those, at least, which are comparatively recent. This has been done in the tables C and D, compiled from the Army Medical Department Reports. It has not been possible to obtain the numbers killed in action in every case, so that the element of total loss is absent. The first table (C)[1] shows the admissions and deaths as ratios per 1,000 of the average annual strength; the admission rates have been given to the nearest whole number. In the second table (D)[1] the ratios for the total admissions and deaths have been shown in the last column, while in the other columns, under each heading, is shown the *percentage* of the total admissions and deaths which is due to the cause shown at the head of the column — an arrangement which facilitates comparison.

Unfortunately, except in one case, the duration of the campaign was less, usually considerably less, than one year. This involves in the first place, a statistical error, due to the multiplication of ratios which are originally derived from small numbers, and, secondly, an error in distribution, because the campaigns are limited to a portion only of the year, while, as seasonal prevalence is usually an important feature in the history of a disease, campaigns in different latitudes and at different seasons are not strictly comparable. So that it is hardly possible to regard the incidence and mortality ratios as giving more than an approximation to the actual

[1] In Appendix.

normal morbidity and mortality under an equality of general conditions. But if these sources of error be borne in mind, it appears possible to obtain some useful information from the comparison of the figures.

One of the objects with which these tables were prepared was to endeavour to ascertain whether there was any relation between the duration of the campaign and the prevalence of the continued fevers. As regards non-infective types of disease, there seems to be no reason why any relation of this kind should exist, but it will be shown later that in South Africa, as in the Cuban War, there was a limit of time during which no great development of these fevers occurred. On the other hand, there appears (at least in individual instances) to be an upper limit to the development of an epidemic, a limit determined by several factors, of which the unequal susceptibility of the individuals of the force exposed is probably one of great importance, while the development of sanitary measures after the first confusion of the beginning of the campaign may also be of the highest importance in certain instances. Taking these two elements in conjunction, the delay in development and the tendency to a limit after a certain duration or stage of development, one would expect to find the greatest prevalence in campaigns of medium duration. This, of course, assumes an equality of conditions which probably does not exist, and, indeed, is known not to exist in the campaigns under consideration. Hence probably it is that the actual results do not in any way conform to what would follow on these theoretical considerations, as may be seen from the following table :—

ADMISSIONS FOR CONTINUED FEVERS IN ORDER OF MAGNITUDE.

		Duration, days	Average strength
Less than 100 per 1,000 of strength			
25 China Field Force	1900-01	383	1,277
60 Mashonaland	1896-97	192	266
67 Eastern Soudan	1884	53	583
100-200 per 1,000			
143 Matabeland	1896	211	384
146 Suakin	1885	75	1,487
161 Nile Expeditionary Force	1884-85	504	7,790
168 Chitral Relief Force	1895	180	2,571
199 Nile Field Force	1889	36	150
200-300 per 1,000			
204 South African War	1889-1902	961	208,226
270 Soudan	1885-86	57	917
291 Nile Expeditionary Force	1898	255	3,510
Over 300 per 1,000			
315 Egypt	1882	85	3,036
320 Dongola Expeditionary Force	1896	205	575

Detailed examination of these tables shows that there is no correlation, either positive or negative, between the duration of the

campaign and the prevalence of continued fevers—that is, that there is in them no evidence to show whether or not the duration has any influence on the total incidence.

Several points may be noted in tables C and D. The first is the very considerable variation in the total sickness, ranging from a minimum of 541 in the Matabele campaign, which was conducted under rather special conditions, to a maximum of 2,504 per 1,000 in the campaign of 1882 in Egypt. The arithmetical mean of the admission rate and the variability are shown in the bottom line of Table A. But this mean takes no account of the importance of the individual campaign: the Nile campaign of 1889, lasting thirty-six days, with an average annual strength of 150, is of the same value as the South African War, lasting 961 days, with an average strength of 208,226. Hence a mean weighted in proportion to the troops engaged gives a better approximation. The results are summarised below:—

Admissions from all Causes, per 1,000 of Strength.

Arithmetical mean	1,102 ..	Variability, 50·46 per cent.
Weighted mean	1,061	
,, ,, less S. African War	1,148	

Admissions from all Diseases, per 1,000 of Strength.

Arithmetical mean	956 ..	Variability, 46·36 per cent.
Weighted mean	946	
,, ,, less S. African War	1,050	

Difference, equal to Admissions from other Causes than Disease.

Arithmetical mean	146 per 1,000,	or 13·2	per cent. of the total.
Weighted mean	115 ,,	10·8 ,,	,,
,, ,, less S. African War	98 ,,	8·5 ,,	,,

In the South African War itself the total admissions were 958 per 1,000 from all causes, of which 88 per cent. were on account of disease, 12 per cent. on account of other causes. These numbers compare very favourably with some of our previous campaigns. They also differ distinctly from the mean of the previous campaigns, though the difference from the mean of the whole, including the South African War, is not significant, because the latter is so enormously more important that its predominant influence cannot be brought in a proper relationship with the previous smaller campaigns. On the whole, the results in the South African War are the best we have attained so far.

It is hardly possible to compare the mortality-rates in the same way as the admission-rates, as they are conditioned by so many influences which differ from those influencing the admission-rates, but which, like them, vary from campaign to campaign. The most important influence is the proportion of deaths from wounds in action, seen at its maximum in the campaign in the Eastern

Soudan in 1884, where all the deaths were due to wounds. The proportion of deaths from wounds bears a general relation to the numbers killed in action, and like it, depends on the nature of the resistance of the enemy.

One other point to notice is the occasional importance of other causes than disease or wounds in leading to inefficiency and death, especially in Mashonaland, 1896 (admissions), China, 1900 (deaths), and the Nile Field Force, 1889 (deaths).

The most important items in the table are the incidence and mortality rates for the *continued fevers*.

	Incidence	
Arithmetical mean	182 ..	Variability, 51·24 per cent.
Weighted mean	202	
,, ,, less S. African War	200	

Here, again, the South African figures (204) compare favourably with individual campaigns, but do not differ materially from the weighted mean of the series. There is little to be gained by discussing the vexed question of the past, the differential diagnosis of enteric from the other continued fevers met with under war conditions; the most effective commentary is a statement of the case mortality in each campaign taken in order of date.

Campaign	Enteric Fever			All Continued Fevers			Ratio enteric. All continued fevers, %
	Cases	Deaths	Case mortality	Cases	Deaths	Case mortality	
Egypt, 1882 ..	118 ..	27 ..	22·9 ..	956 ..	28 ..	2·9 ..	12·3
E. Soudan, 1884 ..	39 ..	— ..	— ..	39 ..	— ..	— ..	100·0
Nile, 1884	760 ..	277 ..	36·4 ..	2,395 ..	283 ..	11·8 ..	31·7
Suakin, 1885 ..	88 ..	11 ..	12·5 ..	217 ..	11 ..	5·1 ..	40·6
Soudan, 1885-86 ..	95 ..	17 ..	17·9 ..	248 ..	17 ..	6·8 ..	38·3
Nile, 1889	5 ..	1 ..	20·0 ..	30 ..	1 ..	3·3 ..	16·6
Chitral, 1895 ..	326 ..	94 ..	28·8 ..	431 ..	94 ..	21·8 ..	75·6
Matabele, 1896 ..	34 ..	11 ..	32·3 ..	55 ..	11 ..	20·0 ..	61·8
Dongola, 1896 ..	40 ..	20 ..	50·0 ..	184 ..	20 ..	10·9 ..	21·7
Mashona, 1896-97 ..	16 ..	— ..	— ..	16 ..	— ..	— ..	100·0
Nile, 1898	299 ..	83 ..	27·8 ..	1,021 ..	83 ..	8·1 ..	29·4
China, 1900 ..	26 ..	10 ..	38·4 ..	32 ..	10 ..	31·2 ..	81·2
S. African War ..	57,684 ..	8,020 ..	13·9 ..	90,717 ..	8,043 ..	8·9 ..	63·5

The results are summarised below.

Enteric Fever alone: Deaths per 100 Admissions.

(1) 12 Campaigns ..	Cases, 1,846 .. Deaths, 551 ..	Case mortality, 29·85 ± 0·72 per cent.
S. African War ..	,, 57,684 .. ,, 8,020 ..	,, 13·90 ± 0·097 ,,
	Actual difference ..	15·95 per cent.
	Probable difference ..	0·73 ,,
(2) Arithmetical mean of the whole series		23·15 ± 2·56 per cent.
(3) Weighted mean (weighted relatively to the number of cases.)		
Whole series		18·24 per cent.
,, ,, less S. African War		26·81 ,,

Notes.—(1) Gives probably a fairly accurate means of comparison, for the campaigns showing a heavy case mortality on a small incidence are compensated for by

those having none; that is, *the case mortality in the South African War was certainly less than half that experienced in the series of previous campaigns.* (2) Gives too great prominence to individual campaigns. (3) Is probably the most accurate method of comparison, showing the very great influence of the South African War in reducing the average case mortality over the whole series.

ALL CONTINUED FEVERS: DEATHS PER 100 ADMISSIONS.

12 Campaigns ..	Admissions, 5,624 ..	Deaths, 558 ..	Case mortality, 9·92 ± 0·27 per cent.
S. African War..	,, 90,717 ..	,, 8,043 ..	,, 8·87 ± 0·06 ,,

Here the difference between the two case mortalities is small, but significant. The inference is that, *under any circumstances the cases of greater severity, those most likely to prove fatal, are diagnosed enteric fever.*

The case mortality from enteric fever alone in the South African War is, without doubt, the lowest case mortality of statistical value which we have ever obtained in the field. Case mortality in enteric fever in different campaigns depends essentially on diagnosis, and the statistical results confirm the opinion formed during the campaign, that the diagnosis of enteric fever was carried out more freely than has ever been done before. Of the total number of cases of continued fever admitted to hospital, 63·5 per cent. were returned as enteric fever, a proportion which previous experience in South Africa had shown to be probably accurate. In the comparison with some other campaigns, such as Chitral and China, one has to remember the possible confusion with malarial fevers, which, on the whole, tends to diminish the continued fever class.

Working back from the case mortalities to the admission-rates, it seems probable that our admission-rates in South Africa for enteric fever have to be diminished by a considerable percentage to allow of their comparison with the results in previous campaigns: probably a diminution of about 30 per cent. would not be too great. But, at the same time, it must be remembered that the South African results probably approximate to the true incidence under such conditions, while in the other campaigns the incidence has been under-estimated.

DYSENTERY.

Only eleven campaigns are available for comparison here. In the others no particulars are given. For the proper comparison of diseases in this group, diarrhœa should also be shown, but it has not been possible to get a series of figures for this item. Taking dysentery alone, the following are the means for the admissions per 1,000 of strength :—

Arithmetical mean	113·5 ..	Variability 57·95 per cent.
Weighted mean, whole series ..	105	
,, ,, less S. African War	128	

The admission-rate in the South African War, 86 per 1,000, compares well with most of the previous campaigns, and its influence is evident in reducing the weighted mean.

As regards the case mortality, there are no very great variations in the series—that of the South African War, 3·52 per cent., is about the average of the previous campaigns. The remaining items do not call for any special consideration at this point.

PART II.

CHAPTER VI.

The Prevalence of Epidemic Disease in the Field.

I.—In Previous Campaigns.

As has been already pointed out, by far the most important feature of the disease history of the South African War was the development of epidemic disease: 30 per cent. of the admissions and 45 per cent. of the deaths from all causes (including killed in action), or 86 per cent. of the deaths from disease, were due to *continued fevers* and *dysentery*.

This predominance is, of course, common to all campaigns in tropical or sub-tropical regions, as has been shown in the last chapter. Possibly the best way to obtain an idea of the importance of these diseases is to consider them in relation to the admissions and deaths from all diseases. The results (shown below) give their incidence and mortality as percentages of the *total disease* incidence and mortality:—

Campaign	Admissions, Per cent.	Deaths, Per cent.
Nile F.F., 1889	42*	100*
Soudan, 1885-86	39	87*
Egypt, 1882	24	66*
Chitral R.F., 1895	26	90
Mashonaland, 1896-97	38*	—*
Dongola E.F., 1896	34	49*
Matabeleland, 1896	38*	100*
Nile E.F., 1898	48	89
China F.F., 1900-01	9	71*
Nile E.F., 1884-85	40	88
S. African War, 1899-1902	34	86

Certain of these percentages are drawn from too few figures to be trustworthy; these are marked with a star. If the percentages be arranged in order of magnitude, it will be found that as regards the admissions the value for the South African War heads the lower group, and there is a significant difference between this and the lowest value of the upper group, that is, the percentage of the total disease admissions due to epidemic diseases was in South Africa low as compared with previous experience. As regards the deaths, the

only significant values lie between 86 per cent. (South African War) and 90 per cent. These may be taken to be identical; the figures for the South African War have, however, the greatest value from their very great number in proportion to the others. The normal percentage of disease deaths due to epidemic disease in our past experience may then be taken as 86 per cent. of the total.

There is, then, every reason for a detailed examination of the conditions under which these diseases appear, in the hope that this may assist preventive measures in future campaigns.

The circumstances of the South African War were in some ways favourable to such an examination, as will be seen later; in other ways they were unfavourable, in that detailed histories of individual outbreaks are only rarely available. This, however, is the less important, in that every one now accepts as effective in particular times and places the various modes of propagation which have been shown to be actually or probably effective: water, foodstuffs (especially milk), dust, flies, personal contact. Further, the conditions were such that probably each of these possible modes of propagation played its part in most, if not in all, of the outbreaks, or it might be more accurately said, in the steady prevalence of disease throughout the War. But though this was the case, the examination seems to show that the one predominant factor was all that may be included under the term "personal infection."

This predominance of epidemic disease is not, of course, peculiar to the British Army, as some of our critics appear to believe. One has only to turn to such a book as Dr. Otto Niedner's "Kriegs-epidemieen des 19 Jahrhunderts" to see that this predominance affects every army in every clime. The latest comparison is with the Japanese Army in the Manchurian War. Their *recorded* admission-rate for these epidemic diseases was certainly considerably smaller than ours in South Africa; their mortality was a little smaller, but the case mortality for these diseases in the Japanese army was 33·4 per cent. of the admissions, in South Africa it was 9·8 per cent. of the admissions for enteric fever and dysentery only, 7·28 if the other continued fevers are included. The two sets of ratios are then really not comparable; the standard of diagnosis in the two cases has been absolutely different.

II.—Between 1899 and 1902.

(1) The history of the Army in South Africa, in relation to the two epidemic diseases, enteric fever and dysentery, may be divided into two phases: the first that of the invasion, development, and dissemination of these two diseases; the second, that during which both diseases were more or less generally prevalent, varying in the

degree of incidence according to seasonal changes and to local conditions. The first period was characterized by certain severe epidemics, of which the more important were those in Ladysmith, Bloemfontein and Kroonstadt.

(2) *The Period of Invasion and Development.*—Here one has to distinguish between two bodies of troops which differed essentially in environment, those shut up in beleaguered towns, Ladysmith, Kimberley, and Mafeking, and those with a greater degree of freedom, in the field or on the Lines of Communication.

Experience would also lead one to expect, from differences in the geographical position and the relationship to the rainy season, a somewhat earlier outbreak in Natal than on the western side. Further, there was this difference between these two areas, that enteric fever had been prevalent in the garrison of Natal to a considerable degree in the seasons 1896-97, 1897-98, and 1898-99; while in the West, little or no enteric fever had occurred among the troops,[1] who, however, were not stationed in the towns afterwards invested by the enemy. So that, on the one hand, some of the troops and all the localities were infected; on the other, though the towns were infected, the troops were relatively free from infection.

It appears necessary, then, to outline the development of enteric fever :—

(*a*) In Natal (i.) in the garrison of Ladysmith; (ii.) in the Natal Field Army.

(*b*) On the Western line, and specially (i.) Lord Methuen's force, (ii.) the force under Lord Roberts.

(3) As a preliminary, it is essential to the proper understanding of the position, to consider the relation of the so-called simple continued fever to enteric fever. It appears to be possible to come to some definite conclusion as regards the particular case of South Africa, a conclusion which may be stated as follows :—

(*a*) There is no lower limit to the reaction following specific enteric infection—that is, there is no febrile attack, however slight or evanescent, which may not in fact be due to specific enteric infection.

(*b*) A comparison of our records in various parts of the globe over a series of years shows that where other specific fevers (malarial and Mediterranean fevers) are absent, variations in the prevalence of the indefinite class (the so-called simple continued fever) follow very closely variations in the recorded prevalence of enteric fever—strong evidence of their common origin, although the relative proportions of the two are not always constant.

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[1] See table of cases for these years, p. 15.

(*c*) Malarial and Mediterranean fevers being practically absent from South Africa, one can only conclude that the great majority of cases of continued fever occurring there are closely related to and probably are, in fact, enteric fever.

It is, however, hardly justifiable, even in South Africa, to take the whole class, simple continued fever, as being in fact enteric fever. If one looks at it simply from the preventive side, and circumstances permit of effective isolation, segregation, and disinfection being carried out in every case of continued fever, it is certainly safer to exceed the actual numbers requiring these special measures than to omit any. But this does not give the true incidence of the epidemic disease. There appears to be certainly one form of ephemeral fever which is not due to any specific typhoid infection, but to fatigue, especially in connection with exposure to the sun,[1] or to a high temperature. A large number of cases of this nature occurred during the operations in the Orange Free State, in the relief of Kimberley and rush to Paardeberg. There is apparently one form associated with congestion of the liver, most common at times and in those places where great daily variations of the external temperature take place, and another, associated with constipation and general gastric derangement, correlated with an excessive nitrogenous diet, and, like the last, often associated with too much alcohol. It is possible that the last two may be due to an abnormal growth of the intestinal flora, but they appear to be distinct from a true typhoid infection.[2] The class simple continued fever as it stands also includes a certain proportion of cases which should have been returned under some other specific disease. One must not overlook the possibility that some of the indefinite fevers may have been the "phlebotomus" fever first described by Doerr.

It is difficult at the present moment to deal with the question of what proportion of these simple continued fevers are actually enteric fever. We have behind us many series of statistics in which the diagnosis was based solely on clinical features, &c. (which are untrustworthy) and the probabilities. We have series of cases in which laboratory methods showed larval, abortive and extremely irregular forms to be actually typhoid infections. But we have not as yet any general series giving the results of the bacteriological examination of a large number of consecutive febrile cases, and until we get that, we cannot say accurately what proportion

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[1] See the results of observations by Dr. Haldane, Dr. Sutton, and others.

[2] See Fieker, *Arch. für Hygiene*, lvii., p. 56, on the influence of overwork on the permeability of the intestine to bacteria.

these irregular forms bear to the well-marked cases, nor what proportion are free from typhoid infection. In Maritzburg between 1891 and 1897 (where the diagnosis practically rested on clinical evidence) of 977 consecutive cases of continued fever, 30·6 per cent. were returned as enteric fever, the remainder—69·4—as simple continued fever. These last fell into two distinct classes according to severity and duration: 29·7 per cent. were relatively severe, and were probably actually enteric fever; 39·8 per cent. were mild, and a proportion were possibly enteric fever. That is to say, during the period the recorded enteric fever did not represent quite half the probable actual incidence. Again, during the whole twenty weeks of the epidemic at Bloemfontein in 1900, the cases returned as enteric fever represented 57 per cent. of the total cases of fever, but during the first eight weeks they represented only 39 per cent., while during the last twelve weeks they rose to 73 per cent. of the total febrile cases. There was certainly a change in the standard of diagnosis after the first eight weeks had elapsed, though there was no difference in the type of disease. There appears to be no question that the cases of enteric fever were not fully diagnosed during the first period, and we certainly had the impression during the later period that any possible errors were in excess. Probably we should be nearly correct in saying that about two-thirds of the total febrile cases were in fact enteric fever;[1] further, in considering possible foci of infection and channels of dissemination, we must take every recorded case of simple continued fever as possibly enteric fever.

As regards the differentiation of paratyphoid from enteric fever, it does not appear at the present stage to be a matter of practical importance.[2] If it is as infective as true enteric fever, if it causes as much inefficiency, either by the number of individuals affected or the prolonged duration of individual attacks, it is not important from the point of view of prevention to differentiate between the two diseases; measures which hinder or prevent the development of the more fatal disease will also inhibit the milder form. Further, there was during the War no attempt to make this distinction, then barely recognised.

(4) The materials available for the discussion of the mode of development of these epidemic diseases are derived from the fugitive weekly returns, rendered of necessity somewhat hurriedly, and in

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[1] Of the recorded cases of continued fever in South Africa, 63·5 per cent. were returned as enteric fever, the remainder as simple continued fever, which agrees with the hypothesis stated above.

[2] *See* Birt, JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, vol. ix., p. 145; and Statham, p. 226 *et seq.*

which the diagnosis of the included diseases is therefore sometimes doubtful. But if we deal in large groups, associating the diseases most likely to be confused, we shall have materials which are probably not vitiated by any serious error, and we can later dissect these groups into their components, which, however, will probably be less accurate.

With regard to the general question, the diagnosis of disease on service, it must be remembered that where the staff is overworked, where there is pressure on the hospitals and difficulty in carrying out the primary duty of the hospital, the actual succour of the sick and wounded, all clerical work tends to be neglected, or at least minimised as far as possible. When sick returns had to be made up weekly, two courses were open in the obscurer cases: either to diagnose provisionally with a view to changing the diagnosis later if further observation showed the necessity, or to leave the diagnosis open for the moment, returning the case as "not yet diagnosed." Now either of these courses, when carried to its conclusion, involves additional clerical labour, a thing that is of little moment in times of peace, but one which is to be considered with the reduced staff available during times of pressure, when every trained man is needed for ward work. Hence, under this system of weekly returns the *record* of diagnosis often failed in accuracy; this, however, did not involve any failure in the actual diagnosis and treatment. The difference between the two is vital. Under the present arrangements, with the diminution of the actual clerical work in the hospitals, the same difficulty should not arise to any great extent. But it must be remembered that if scientific accuracy in every detail, especially in the records, is expected on service (as indeed it should be), then a sufficiently large staff must be available. Accurate record is of the highest importance, but the time and energy of officers and men must first be directed to the care of the sick and wounded, and if the trained staff suffices for this alone, then the accuracy of the records must and will suffer. Such was the case during a great part of the South African War, where the trained staff became relatively smaller as the War went on.

(5) The two disease groups of importance here are, first, the continued fevers—practically consisting of enteric and S. C. fevers, with possibly (chiefly in the Ladysmith garrison) a few relapse cases of malarial fever. On the other hand, a few cases of continued fever may have been included in the malarial group. There is no reason to believe, however, that this source of error attained any magnitude; there was in all probability no fresh malarial infection in Natal. The second group—of all bowel complaints—includes dysentery, diarrhœa, and inflammation of the intestines. It is obvious that these two main groups are not mutually exclusive

in such circumstances as obtained during the War. Apart from the probability that some proportion of the cases of diarrhœa were in fact manifestations of enteric infection, one knows as a matter of experience that the differential diagnosis of enteric fever from dysentery, or from inflammation of the intestines, is not always a simple matter when clinical methods are alone available and the time under observation is limited. But while we cannot claim absolute accuracy for these figures, it probably may be assumed without any serious error that these two groups of figures broadly represent the actual conditions as to prevalence in time and place, and if we bear the probable sources of error in mind their consideration may prove instructive.

(6) Diagrams have then been prepared from the weekly returns from the hospitals, dealing with the two main groups of diseases referred to above—for the two large bodies of men in Natal—the Garrison of Ladysmith and the Natal Field Army—for the Western line (De Aar, Orange River, Modder River), and lastly for the force advancing to Kimberley and Bloemfontein, and in Bloemfontein itself.

The two Natal groups will be considered first in some detail, and in relation to one another. Their consideration also gives an opportunity for the discussion of some general features which affect all the examples in some, usually an important, degree. Finally, the various outbreaks will be compared with one another.

(7) Development in Natal.—In these two bodies of men in Natal we find the greatest differences in environment. We have on the one hand the beleaguered and starved garrison of Ladysmith, on the other the well-fed and mobile field army; the one confined to a limited and infected area, the other unhampered and on normal soil; one composed almost exclusively of seasoned troops, the other containing a much larger proportion of young soldiers. Yet, with these differences, there is a great similarity in the disease relations of the two groups.

A.—In the Garrison of Ladysmith.

(i.) *Composition of the Garrison.*—The garrison of Ladysmith was almost entirely composed of what we would term "seasoned" men. That is, excepting two battalions of infantry from the Mediterranean, and one from Egypt, which arrived after August, 1899, the whole of the troops had served either in India (from which they were sent to Natal), or had been in South Africa, and (with one exception, the 1st Battalion Liverpool Regiment) indeed in Natal during at least one hot season. That is, of course, setting aside drafts which may have joined them (the regiments in South Africa)

direct from England, but which in no case formed more than a small proportion of any unit. Of the 12,700 of all ranks in the garrison, some 1,700 had been inoculated against enteric fever, at periods varying from two to eleven months before their arrival. The Liverpool Regiment indeed were inoculated in Ladysmith. Apart from the question of the effect of inoculation on the small proportion who were so protected, one finds that in spite of the (acquired) partial immunity which our experience would lead us to believe that these "seasoned" troops would have shown under ordinary peace conditions, the circumstances were such that the actual incidence of enteric fever on the whole garrison was very heavy.

From the beginning of November, Ladysmith was an isolated area; no cases were brought into it from outside.

(ii.) *General Sanitary Conditions.*—In order to understand the position, we must consider the previous history of Ladysmith. After having been unoccupied as a military station for many years, this small town was re-occupied in May, 1897. No barracks existed; those prepared for the troops were of a temporary nature, and the arrangements (especially the drainage system) were based on a probable short occupation, and were therefore somewhat inadequate. The water supply in particular was bad. As shown in the table,[1] the garrison of Ladysmith suffered severely from enteric fever during the hot seasons 1897-98 and 1898-99 (as did the civil population) and, as a consequence, both the military camp and the town were infected areas. As a result of the epidemic in 1898-99, the sanitary conditions of the camp were considerably improved, including the provision of a new intake for the water supply, which however was still drawn from the Klip River.

The circumstances attending the earlier operations in Northern Natal prior to the siege were not such as to admit of any special attention being paid to the development of sanitary improvements, and as a consequence, the commencement of the siege found a thickly populated area (about 21,000 souls, civil and military) devoid of any special provision for the sudden increase of its population.

A pail system is used for the removal of excreta almost universally throughout South Africa. This system, always undesirable, and requiring careful supervision, is not suited to the sub-tropical climate of Natal, where, amongst other objections, labour difficulties result in the system being very carelessly carried out. The conditions in Ladysmith in this respect were probably no worse than elsewhere, but they contributed to the fouling of the soil and water supplies, and so to the spread of infectious diseases. We had therefore at

[1] p. 15.

Ladysmith three factors provocative of an epidemic, a bad water supply, a bad removal system, and a polluted soil.

(iii.) *Water Supply.*—The water supply merits some special consideration. The source was the Klip River, a tributary of the Tugela. This, like other South African streams, varies greatly in volume according to the season; much and rapidly affected by heavy rain, at such times it carries down a large quantity of mineral matter, and even in the dry season the water contains a large quantity of finely divided inorganic matter, which clogs sterilising filters. In addition to this, analyses showed that it was highly contaminated by organic matter, probably from drainage from the town. Efforts were made to eliminate this last factor by the provision of a new intake higher up the river, but the supply so provided was insufficient for the garrison during the siege and was, in fact, cut off by the enemy at the beginning of the investment. An installation of Berkefeld and Pasteur-Chamberland filters with the necessary tanks and pumps had been ordered for the use of the permanent garrison, and was despatched to South Africa, but did not arrive in Ladysmith before the siege.

During the occupation of Ladysmith (before the War), various methods of purification had been adopted. The water was clarified by the addition of alum, or by a rough filtration, and was afterwards boiled. Sterilising filters had been used privately, but were found, as in Maritzburg, to require constant attention and cleaning to maintain the output. During the siege, the water was perforce taken from the old intake, within the drainage area of the town, the surrounding lines and portions of the Boer positions. Hence, the pollution of the water during the siege must have been worse than during the period before the War, if that indeed were possible. Some small, indeed almost negligible, supplies of better quality were available, "the tanks of aerated water factories," and "rain water from various tanks throughout the town."

To remedy these defects several measures were taken. The engineers of the "Powerful" in conjunction with the railway authorities erected a condensing plant, using locomotive boilers; this allowed of a supply of condensed water for a portion of the garrison, at first about half a gallon per head per day, later on when fuel became more scarce, about one-quarter gallon. The water was also cleared by alum and sedimentation, or by rough filtration through square or pyramidal "jelly-bag" filters of linen, stretched on wooden frames, and filled with wood ashes, a system originating in the field hospitals, and afterwards extended to all units. The cleared water was then boiled when fuel was available.

It is impossible to ascertain how far these methods of purification were applied to the water actually drunk by the troops. In

the circumstances of the siege, the wide area covered (with a perimeter on the inner line alone of 14 miles), the incessant coming and going of larger or smaller bodies of men, the probabilities are that even though means of purification were available, yet most of the water actually consumed was in an unpurified condition. More than one officer who served in Ladysmith during the siege has mentioned an apparent improvement in the health of the troops under his immediate observation, following on the adoption of one or other of these forms of purification. But it is probable that under the conditions of the siege every unit in the garrison was exposed during some part of each day to the average conditions of the *garrison* as distinct from the *regimental* conditions, and the consolidated statistics of the whole garrison during the whole period of the siege do not show any improvement which can be attributed to these measures. There certainly was a temporary decline in the admissions for all continued fevers during the latter half of December, which may equally well be attributed to other causes, and there was a decline which was permanent in the recorded cases of enteric fever from the same date. But this would appear to be the result of a change of nomenclature, and not a real diminution of the disease.

The actual connection between these probable causes and the epidemic may be deferred until the features of the development in the field army of Natal have been outlined.

(iv.) *The General Incidence of Disease.*—The strength in Ladysmith on November 2nd, 1899, was as follows [1] :—

Officers, other ranks and white employees	12,700
Cape boys and Kaffirs	1,400
Indian natives	1,500
Horses	5,800
Mules	4,342

The statistics of sickness refer only to the Europeans, 12,700, but the other details have been added to give an idea of the additional difficulties in sanitation in a closed area. The civil population brought the total numbers up to 21,000. The garrison was, as has been pointed out, almost entirely composed of seasoned units.

Between November 2nd, 1899,[2] and March 2nd, 1900—121 days—the cases of epidemic disease admitted to the hospitals were as follows :—

[1] Ward, Appendix 37, Royal War Commission.

[2] The beginning of the siege. The incidence before this was extremely small; it is shown in the figure.

Enteric fever cases	1,280 ..	Deaths 360	Total cases	2,250
Simple continued fever cases	970 ..	—	,, deaths	360
Dysentery cases	1,841 ..	Deaths 105	Total cases	2,374
Diarrhœa ,, ...	491 ..	—	,, deaths	105
Inflammation of intestines ..	42 ..	—		

giving incidence rates per 1,000 per annum of 533 for the continued fevers, for dysentery alone 438, and 563 for bowel complaints, and a case mortality for enteric fever alone of 28 per cent., for all continued fevers of 16 per cent., for dysentery 5·70 per cent., or all bowel complaints 4·42 per cent.

These incidence rates are, of course, only approximate; no allowance has been made for wastage, so that the actual rates were even higher than these enormous rates. The type of disease may also be estimated from the case mortality,[1] which is unusually high, and probably determined largely by the conditions of the siege.

Incidence rates per annum are, of course, hardly applicable here, but it is only by using them that any comparison with other outbreaks can be made.

The weekly variations in the number of admissions for the groups (continued fevers and bowel complaints) are shown in fig. 5. The first fourteen weeks—to January 19th—are comparable with the same period in the field army. The characteristics of the epidemic will be summarised later. In fig. 6, the fevers are differentiated into enteric and simple continued fever, and it will be observed that the proportion is not constant throughout, but that simple continued fever, while low in the early period, actually predominates from January, 1900. The deaths from enteric fever are also shown; they attained a high level about four weeks after the maximum incidence of enteric, and that high level was maintained to the date of the relief. No deaths occurred from simple continued fever during the period under review. It is hardly possible to come to any conclusion but that the difference in the periods before and after the beginning of the year was diagnostic, not essential, and that there was no material change in the type of disease.

The early predominance of dysentery is also shown in the upper part of the same figure.

B.—The Natal Field Army.

(i.) *Composition.*—The troops in Southern Natal consisted almost entirely of the force for the relief of Ladysmith, there was but a relatively insignificant number of troops on the Line

[1] The mean case mortality over the whole war was 13·9 for the continued fevers, and 3·53 for bowel complaints.

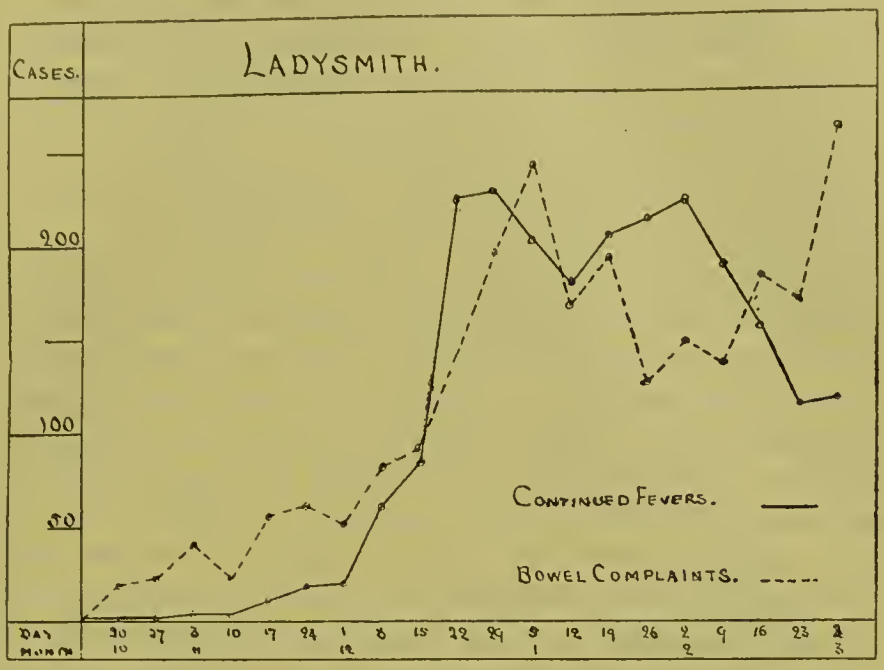
CASES.
LADYSMITH.
200
100
50
CONTINUED FEVERS.
BOWEL COMPLAINTS.
DAY
MONTH

FIG. 5.

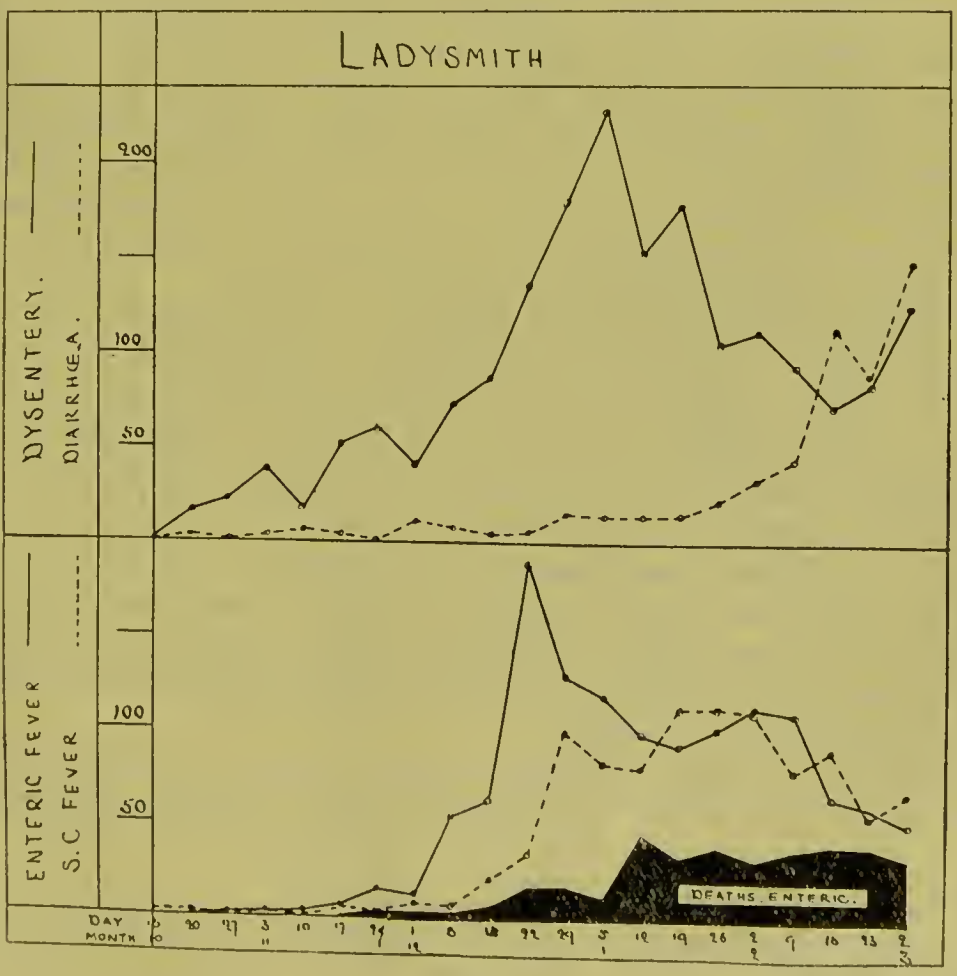
LADYSMITH
DYSENTERY.
DIARRHŒA.
200
100
50
ENTERIC FEVER
S.C FEVER
100
50
DEATHS. ENTERIC.
DAY
MONTH

FIG. 6.

of Communication and elsewhere. The relief force began to concentrate at Estcourt and Frere in the end of November; the concentration was completed early in December, and on the 9th of that month the strength of the relief force at Frere was approximately 706 officers and 18,762 of other ranks.[1] Troops landed in Natal during the remainder of December and the first few days of January, 1900, bringing the total in Southern Natal to about 902 officers and 26,067 other ranks on February 11th.[2] All the troops landed in Natal at this time were from England, and the embarkation returns[3] show that of 20,679 infantry embarked, 10,404, or rather more than half, were reservists, so that the proportion of young soldiers in the ranks must have been low. Besides these immigrant troops, there were, both in the field and on the line of communication, Colonial Corps, composed at this time almost entirely of residents in the country. Hence the army in Southern Natal was comparatively well seasoned. It may, however, be noted that the *recent* exposure to enteric infection had been much less in this group. From the beginning of January, the composition of the force did not vary materially.

(ii.) *General Hygienic Conditions.*—One may summarise the main elements in the hygienic relations of the field army as follows: the water supply was from various sources at different times, usually—indeed, almost always—river water; it was almost entirely unfiltered. The food—the war ration—was good and sufficient. The disposal of excreta and of refuse was on the usual lines under war conditions—that is, imperfect. These points will be further discussed in another section.

The hygienic conditions on the Line of Communication were of a different type. Neither in Maritzburg nor Durban was the water supply above suspicion; in the former, steps had been taken to improve the supply, and an installation of Berkefeld filters (originally destined for Ladysmith) had been set up, but the general sanitary conditions were not good. Camps had been formed at Nottingham Road and Mooi River in the previous hot season, and had proved satisfactory, and, indeed, the whole of the camps in occupation during the concentration were fairly good, though no special sanitary arrangements beyond those of the usual standing camp were possible.

(iii.) *The General Incidence of Disease.*—The approximate strength of the troops in Southern Natal (excluding the greater

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[1] "Official History of the War," vol. i., p. 333.

[2] These strengths are taken from the Appendices to vol. i. of the "Official History of the War."

[3] Appendix 8, "Royal War Commission."

part of the troops on the Line of Communication) between November 24th and March 2nd was 23,290 Warrant, and N.C.O.'s and men, without allowing for any wastage. Our records of disease consist of those from the field hospitals with the relief force, and those from the stationary hospitals on the Line of Communication. It is, however, not possible to make any accurate distribution of the strength to correspond with these, but the strength on the Line of Communication was relatively very small. If we take the total of the cases from the two groups of hospitals, we shall probably be counting the same case twice over in many instances—once as a case of simple continued fever in the field hospital, and again as a case of enteric in the stationary hospital returns—as under the conditions the change of disease was probably never notified to the hospital from which the case came. Hence, there is overlapping of the two sets of returns to an unknown degree. But fig. 7 shows the admissions to the stationary hospitals (solid black), and also those to the field hospitals, and here it is evident that there is no regular relationship between the two sets of returns.

The field hospital returns from the relief force show the following admissions during the period—

Enteric fever ..	Cases	12	..	Deaths	—	Total cases	867
Simple continued fever	,,	855	..	,,		,, deaths	—
Dysentery ..	,,	957	..	,,	3	Total cases	1,459
Diarrhœa ..	,,	494	..	,,		,, deaths	3
Inflammation of intestines	,,	8	..	,,			

giving incidence rates per annum per 1,000 for the ninety-nine days between November 24th and March 2nd, of 137 for the continued fevers, and 231 for bowel complaints. Both these incidence rates are under-estimated, as no allowance is made for wastage, or for the small proportion of troops on the Line of Communication.

The following admissions were returned from the stationary hospitals during the same period:—

Enteric fever	Cases	142	..	Deaths	59	Total cases	228
Simple continued fever	,,	86	..	,,	2	,, deaths	61
Dysentery	,,	345	..	,,	43	Total cases	510
Diarrhœa	,.	147	.	,,	1	,, deaths	47
Inflammation of intestines	,,	18	..	,,	3		

or adding these two sets together to give the total admissions in Southern Natal:—

Enteric fever	Cases	154	..	Deaths	59	Total cases	1,095
Simple continued fever	,,	941	..	,,	2	,, deaths	16
Dysentery	,,	1,302	..	,,	46	Total cases	1,969
Diarrhœa	,,	641	..	,,	1	,, deaths	50
Inflammation of intestines	,,	26	..	,,	3		

If we take the total cases of continued fevers (1,095) on the approximate average strength (23,290) we obtain an annual incidence rate of 173 per 1,000; similarly for dysentery 264, and for all bowel complaints a rate of 312, with case mortalities of 38·3 for enteric fever alone and 5·6 for all continued fevers, 3·54 for dysentery, and 2·54 for all bowel complaints. Here, again, no allowance is made for wastage on the one hand, or on the other

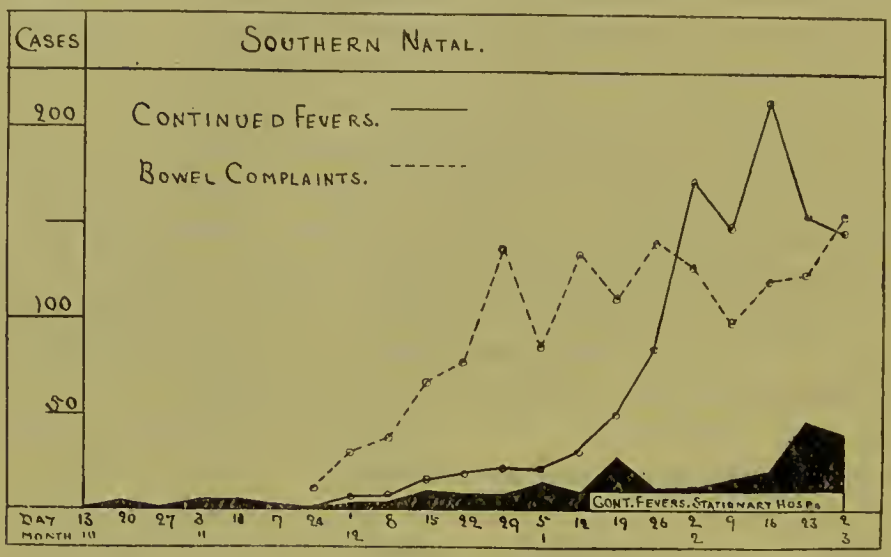

FIG. 7.

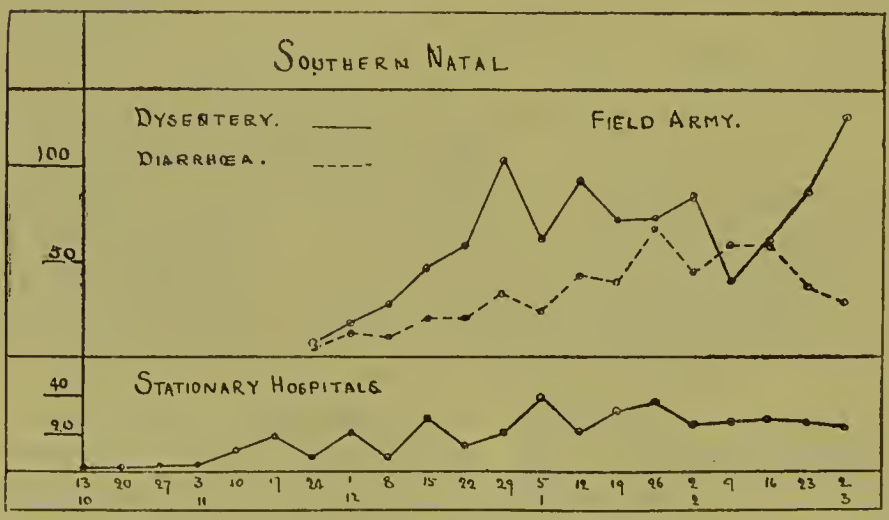

FIG. 8.

for duplicate admissions. But this is probably a maximum rate, as the numbers of Colonial Corps and other troops on the line of communication not disembarked at Durban are not included in the average strength used. Hence, the true incidence of the continued fevers lies between 137 and 173 per 1,000 per annum, and is certainly much under that which occurred in Ladysmith.

The differentiation of the components of the fever curve in fig. 7

cannot be adequately shown in a figure. The main points, however, are the extremely small number of cases of enteric fever recorded in the field army returns (twelve), and the enormous preponderance of simple continued fever; while as regards the stationary hospitals, with the exception of a rise in simple continued fever on January 19th (twenty cases), and again during the last fortnight, and a rise—slow at first and then sudden—in enteric fever from the same date, the admissions remained fairly constant without any suggestion of an epidemic outbreak.

Fig. 8 shows the relation of dysentery and diarrhœa in the field army, and of dysentery in the stationary hospitals. In the former, as in Ladysmith, dysentery was the predominant factor.

(iv.) Having then before us the distribution in time of these cases of disease, as shown in the diagrams, one may proceed to inquire whether there is evidence of any common factor influencing the outbreaks in Ladysmith and in the field army, and on the other hand whether any important differences exist between the curves relating to the two groups of men.

Two features common to both groups are at once evident—the onset of bowel complaints before that of continued fevers, and the long period between the earliest record of continued fever cases and the period of rapid increase in them. Later it will be found that these conditions obtained also in the third great outbreak which began at Modder River, hence their consideration will be deferred till later.

Taking the two Natal groups together, it is possible to find contemporaneous and similar variations in the curves relating to them, both in the continued fevers and bowel complaints. But it is questionable how far one is entitled to use these as a basis for discussion. The statistics to begin with are imperfect, and a simple plotting of the actual numbers, as has been done here, does not give the true shape of the curve, nor a sufficient approximation for any valid conclusions regarding the smaller variations. Hence, it is more satisfactory to limit the discussion to the broader results, and to ascertain, as far as the materials permit, in what degree the recorded results conform to the recognised epidemiological characters of the diseases most in evidence.

C.—Associated Conditions.

The spread of epidemic disease in the field, as elsewhere, is influenced in varying degrees by two sets of conditions, one general or common, the other local and particular to each outbreak. Those common to both these bodies of men can apparently only include:—

(i.) Climatic conditions, especially rainfall, temperature, dust.

(ii.) Water supply.

(iii.) The vicissitudes of war :—

(*a*) Those not directly related to infectivity ; fatigue, exposure, privation, moral conditions.

(*b*) Those directly related to infectivity.

(iv.) The mean incubation periods of enteric fever and dysentery in the infected individuals.

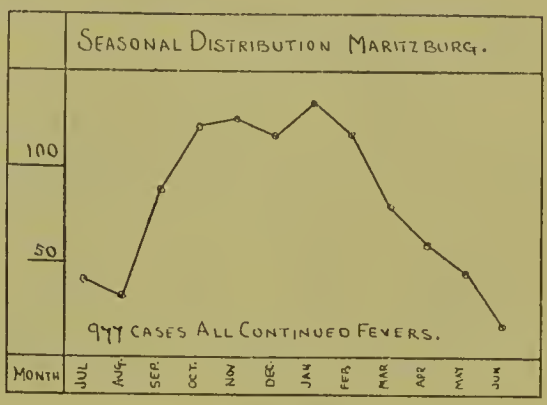

FIG. 9.

(i.) *Climatic Conditions.*—The seasonal variations in the prevalence of enteric fever in Natal in relation to climate have already been referred to. Unfortunately for purposes of comparison, no record is available of the normal prevalence of continued fevers week by week, but fig. 9 shows the monthly distribution of 977 cases of continued fever (simple continued fever and enteric) in Maritzburg between 1891-97 on a total mean strength of 10,475 men. One sees from this, that in both forces in Natal during this period of the War, the outbreaks occurred during the period of normal maximum prevalence, and further, which is also important, that during the first six weeks, the actual prevalence in either body was less than the recorded prevalence in a body of much less strength during peace. Here we are, of course, comparing only one season with the aggregate of eight seasons in which the high prevalence in September, October, and November, is largely due to an exceptional prevalence during these months in the year 1897, and to a less extent in 1891.[1] But even allowing for this, the prevalence during the first six weeks of the period in each case was certainly not greater, and was in fact probably less than might have been expected on the same strength under normal conditions in Natal, if the conditions had remained the same as in the previous eight years. The risk of infection was probably less in the field army at the outset than in Maritzburg, but the same cannot be said

[1] *Vide* Army Medical Department Report, 1898, p. 518.

of Ladysmith, where enteric fever had been very prevalent in the preceding hot season. One can only conclude that the duration of exposure to infection has some influence, that in fact the infection of the *units* of the force is an important condition.

There is a good deal of evidence which suggests that under ordinary conditions, the climatic influence in Natal, as elsewhere, is mainly exercised through the water supply, and possibly also by means of dust. Neither of these factors was negligible in either force; in Ladysmith certainly, pollution of the water supply by the drainage of the rainfall must have been an important element from the very first, and along with it, food pollution from infected dust. The water influence in the field army is more uncertain; less definite evidence is available regarding actual or potential pollution; dust infection was probably more intermittent than in Ladysmith, from the varying environment of the troops. From both these groups, however, one certainly gets the impression that the aggregate of conditions conveniently termed "climatic" was of much less importance than under normal conditions, and that their effects were, in fact, almost obliterated by other influences.

(ii.) *Water Supplies.*—As regards Ladysmith, the evidence of infection, short of the discovery of the *Bacillus typhosus*, may be taken to be conclusive. Here we had a previous infection through two seasons of a large part of the area drained by the Klip River, and evidence of sewage contamination of the supply. All South African streams are liable to great variations in volume, especially as between the cold and the hot season, and the accumulation of *débris* and filth of all sorts on the "dry season bank" is swept into the stream with the first floods. Hence in addition to a persistent but varying degree of contamination by subsoil water from a polluted area throughout the greater part of the year, there is with the first heavy rains a sudden and considerable increase in the organic impurity. These considerations apply as forcibly to the sources of supply of the field army as to the Klip River, but with this difference, which may be important, that the actual degree to which these sources were infected must remain a matter of doubt. It is a bold hypothesis to advance that all the streams in the area of operations were infected, and probably unnecessary, and evidence of the possibility can only be put in general terms. The first proposition is that enteric fever is endemic in Natal, both among Europeans and natives, to an unknown extent, though the general prevalence may possibly not be very great. Durban and Maritzburg were both important foci of distribution. Epidemics also occur among the natives in their own kraals.

Secondly, before the War, attention had been called by medical men throughout South Africa to the dissemination of enteric fever

by natives returning from the mines to their own homes, often in an advanced stage of the disease. This dissemination took place largely along the main lines of traffic, but also along the Kaffir paths which seam the veldt, and the river-bank is the natural place for the native to relieve himself when it is convenient. This comparatively common infection of the natives is also important in relation to the probability of the presence of "carriers" among the native followers of the army, recruited in the Colony.

Thirdly, in the early months of 1899, enteric fever had been generally prevalent in Natal, considerable outbreaks had occurred in Maritzburg and Ladysmith, and a small number of cases are recorded from camps at Nottingham Road and Mooi River, through both of which the troops of the field army passed to Estcourt, Frere and Chieveley, the main points of concentration.

This forms a mass of presumptive evidence which can hardly be neglected, showing the possibility of at least a local infection of the water supplies for the field army. On the other hand, as regards infection by the troops, the railway and main road northwards from Maritzburg to Ladysmith cross the river valleys nearly at a right angle, hence bodies of men proceeding along the main lines had but limited opportunities of infecting or being infected by a stream. Apart from the fouling of the dry bank, a variable quantity, and the adjacent ground, the water actually infected was carried away from the line of advance of the troops. When the troops turned westward after Colenso, the conditions were different in this respect.

Such were the historical and geographical features relating to the water supply of the field army. Whether these supplies were in fact infected or not is a matter of opinion, not of evidence. But we have at least evidence of the general possibility, or even probability, of infection, and the tendency to look on local infections as probable rather than possible will be the greater, the better one is acquainted with the actual details of warlike operations under such conditions as obtained in South Africa, where in addition to the Irregular Forces, impatient of discipline and sanitary control, there was a large native establishment devoid of elementary ideas of decency, and to whom sanitation, even of the simplest type, appears a wild dream.

The means of purification in Ladysmith have already been referred to. Apart from the condensing plant, which afforded a partial supply, the only successful installation appears to have been in the hospital at Intombi, where it was in the charge of Serjeant-Major (now Honorary Major and Quartermaster) F. Bruce, R.A.M.C. Here water was obtained by sinking barrels near the bank of the river; this was clear enough to pass through

Berkefeld filters which had been obtained from the soda water factories in Ladysmith. The daily yield was about 1,500 gallons.

As regards the field army, "Berkefeld filters were to have been supplied to units in the proportion of one per company, but very few battalions had their full complement, and it is doubtful how far those supplied were satisfactory."[1]

The importance of an actual infection of the water supply, supposing it to have existed, is a problem of great difficulty, and little likely to receive a satisfactory solution. Materials do not exist, and cannot possibly exist, to enable one to assign due weight to each of the possible influences determining the actual incidence of disease.

(iii.) *The Vicissitudes of War.* (*a*) *Those not directly related to Infectivity.* — Fatigue, exposure, and privation are influences secondary to actual infection, if one limits the term infection to the actual entrance of the agent into the body. Yet all history shows their importance, possibly most usually recognised in relation to dysentery, a well-known accompaniment of famine and extreme poverty as well as of war in all climates. One has also experimental evidence of the effect of overwork (alone or with starvation) in accelerating the wanderings of *B. coli* from the intestine to other organs.[2] The effects of these conditions are indeed so well known, that it would hardly appear necessary to refer to them but for the fact that their influence has often been overlooked in the discussion of the prevalence of disease in South Africa.

As between the garrison of Ladysmith and the Natal Field Force there were important distinctions in this respect. The field force was well fed, "the troops always received full rations and frequently fresh bread and meat. After a period of specially arduous service, an endeavour was always made while the troops were resting to issue fresh bread and meat and vegetables, such as onions. The benefit to the men who had been living for days on 'bully' beef and biscuit was noteworthy."[3]

In Ladysmith, conditions were otherwise. On November 2nd, when the siege began, there were reserve stores for a force of about 15,600 men of all classes (Europeans and natives), as follows :—

Bread-stuffs, sixty-five days; meat, fifty days; groceries, forty-six days. To this was added all food-stuffs available in Ladysmith, which were requisitioned for general distribution. On the other hand, the civil population, who had to be provided for, brought the total numbers to about 21,000.

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[1] "Report on the Campaign in Natal," by Sir T. J. Gallwey, K.C.M.G., C.B.

[2] Ficker, *Archiv. für Hygiene*, lvii., f. 1, p. 58.

[3] Sir T. J. Gallwey's Report.

The siege actually lasted till March 1st, that is, one hundred and twenty days, while as the date of relief became more problematical, arrangements were made "to reserve a certain amount of food sufficient to maintain existence in the garrison till the latest moment possible. After careful consideration, this date was fixed to be March 31st, and by the aid of horse-flesh and chevril, and a gradually diminishing ration of mealie flour and groceries, a scale was prepared which would have enabled us to hold out until that date."[1] Towards the end of the siege the men were reduced in strength, "they had none of the things that were really necessaries; they had no vegetables, and things of that sort, and no butcher's meat practically. They were really living on mealie flour and various expedients made out of horses."[2] The "expedients made out of horses" were:—[3]

(1) "Chevril," a strong meat soup which was issued nightly to the troops and hospitals.

(2) A condensed form of chevril, which took the place of the ordinary meat extracts, and was of such strength that one part of the extract made upwards of 30 parts of "beef-tea."

(3) "Chevril paste," which was made of the boiled meat and jelly, was issued as a ration at the rate of 1 ounce per man: this was much appreciated, especially by the convalescents. A "special potted meat," made from horse tongues, was manufactured exclusively for hospital use.

(4) A jelly similar to calf's foot jelly, which was used for the enteric patients.

(5) The boiled meat was issued as an extra to the meat ration of the troops, and also to the convalescents, at the rate of ½ lb. per man. (The nutritive value of some of these preparations is probably very low.)

Mealie meal was mixed with flour so that it might be baked and also to make it more palatable, till the flour gave out, when some biscuit was also issued. Mealie meal is of course an excellent food-stuff, but the quantity was small.

The garrison was placed on reduced rations, and the scale descended to the following minimum about the time of the relief:—

Fresh horse meat	1 lb.
Cooked meat	½ lb.
Mealie meal	3 ozs.
Biscuit	¼ lb.
Tea or coffee	⅛ oz.
Sugar	1 ,,

[1] Sir Edward Ward, K.C.B., App. 37, Report of Royal War Commission.
[2] Sir Edward Ward, No. 5,745, vol. i., Report of Royal War Commission.
[3] Appendix 37, Report of Royal War Commission.

Salt	½ oz.
Pepper..	$\frac{1}{64}$,,
Mustard	$\frac{1}{20}$,,
Vinegar	$\frac{1}{10}$,,
One horse sausage ration	
Chevril (for dilution)	⅓ pint.

Attention may be called to the relatively large proportion of nitrogenous constituents. A similar condition obtained on the march to Bloemfontein, and indeed to some extent throughout the whole campaign, at least in the later stages, where though the bread and grocery rations were not in any way deficient, the meat was often in excess of the normal ration. In Ladysmith the want of vegetables, especially in the absence of fresh meat, was a serious deficiency, only partly obviated by the small issue of vinegar, of which a supply had been found in the town.

But whatever effect this food factor had on the maintenance of a high incidence of enteric fever and dysentery in Ladysmith, it apparently had but little effect on the development of the outbreaks (fig. 5); for throughout November, when many of the cases of enteric fever admitted to hospital in the first half of December must have been infected, the condition in Ladysmith was one of precaution, of guarded issue; the stage of actual privation had not then commenced. There is, indeed, no evidence of any close connection between the degree of privation and the intensity of the epidemic: we find the admissions falling when the food conditions were getting worse. One has again to remember that this decline in the admissions for continued fevers in the later stages of the siege, may be due to the fact that the individuals who had not been infected were steadily and rapidly diminishing in number—that is, the susceptible population was actually and relatively becoming smaller. Besides this, it might be expected that other and more potent influences, true infective agencies, would mask the effects of such influence as the food supply might have had.

But if we turn to the admissions for bowel complaints (fig. 6), and if we consider diarrhœa separately from the others, we find a marked increase during the last five weeks of the siege, that is, during the period when not only were the actual conditions worse, but the results of previous privations were beginning to show themselves in a greater reaction of the bowel under infection. No doubt some of these cases of diarrhœa were in fact relapse cases of dysentery contracted at an earlier period of the siege, and their occurrence was determined by the gradual deterioration of the food supplies. Dysentery shows a considerable increase during the last two weeks of the siege. Here probably the question of lessened susceptibility through previous attack need not be considered; there appears to be no evidence of any degree of immunity as a result of an attack

of bacillary dysentery, the prevalent, indeed the sole form occurring in South Africa.[1]

The inference that the greater prevalence of diarrhœa in the last stage of the siege may have been associated with the nature of the available food appears to be justifiable ;[2] beyond this, no definite conclusions are possible beyond a general statement of the probability that the intensity of the outbreaks of both groups of diseases depended in some unknown degree on the unavoidable malnutrition of the individuals exposed to infection.

Turning now to the field army, where the food conditions were practically constant throughout the period, though for a few days at a time some differences may have occurred, one finds that the variations in the intensity of the outbreak, both of continued fevers and bowel complaints, did not differ greatly from those in Ladysmith. We find the same general outline in the curve for continued fevers, the same rise in that for bowel complaints in February, with the difference that here the increase was due to dysentery, and not, as in Ladysmith, to diarrhœa. Further, in the field army, the curve for bowel complaints tends more to the maintenance of a general level, and not to the formation of a definite maximum incidence as in Ladysmith ; here the difference in distribution between the bowel complaints and the fevers is distinct, while in Ladysmith both exhibit the same general features. The outstanding distinction is, of course, in the magnitude of the outbreaks ; the well-fed force was attacked to a much smaller extent. The food factor, however, is only one of many : one can hardly believe that the field army was exposed to an infection of anything like the same intensity as that prevailing in Ladysmith, so that again, no conclusion as to the influence of the ration can be drawn. The increase in bowel complaints, after a fall in the beginning of February, was synchronous in the field army and the garrison of Ladysmith, which, as the field ration was approximately constant in the one, and diminishing in the other, suggests that perhaps the increase in Ladysmith at this time may not have been the result of the deterioration of the ration.

In neither case is there any very strong evidence of any connection of the food supply with the prevalence of disease.

As to fatigue and exposure, there was probably little difference in the degree to which both groups were subjected to these influences, nor is it possible to trace any particular relationship between periods of special stress and of increased sickness, especially as these two elements are so intimately connected with another

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[1] Sir D. Bruce, F.R.S., Report of Commission on Dysentery and Enteric Fever.

[2] But see later under Field Army.

and very important factor, the mental state of the troops in each group. The depressing influences of a siege are well known. At least one of the garrison at Ladysmith felt the monotony of the siege to be its worst feature, a complaint that would not at first sight appear to be at all probable in view of the uncertainty of the position. Sir Edward Ward, in his evidence before the Royal Commission, said on this point, "We noticed as General Buller's force approached us the sick-rate went down, as they retired it went up again."[1] This could, of course, only influence the date on which men infected with enteric fever or dysentery reported sick at hospital, and in this way might have some small influence on the weekly numbers admitted.

It is, indeed, important to note how men will stay out of hospital as long as they are at all able to do any duty, provided that there is something going on, something to interest them: it is in the periods of failure and depression that they feel the weight of disease. This persistence at duty during the early stage of disease was well seen in the number of men sent back to Bloemfontein with enteric fever, within the first few days after Lord Roberts began his advance to Pretoria. It has, of course, a most important influence on the spread of the infection. The field army, on the other hand, was less exposed to depressing influences. No doubt they, too, had their periods of relative depression, but their position was that of a free agent; they had a definite goal to attain, and the pursuit of any object, however difficult, is always more stimulating, possibly because of its difficulty, than the resolute maintenance against odds of a position already reached. On the one side, failure could be but temporary, on the other irretrievable.

It is not possible to estimate the effect of these conditions: all experience tends to induce the belief that their effect would be on the whole towards an increased susceptibility to infection, but there is no measure of their aggregate effect.

(*b*) *Those directly related to Infectivity.*—Local densities of population, that is, such an aggregation as occurs in tents, shelters, trenches and the like, on the one hand, and the crowding together of men in bivouacs, or for protection from the weather or the enemy's fire, of itself involves association with infected individuals, the confusion and exchange of blankets and clothing, possibly infected. It also involves a less direct association through the use of common latrines, through unavoidable proximity between living areas (tents, trenches, &c.), and latrines in use, through the almost inevitable soiling of the ground outside the latrines by excreta or urine, and the cases are few in which this fouling of the soil was

[1] Report of Royal War Commission, vol. i., No. 5,750.

limited to the vicinity of the latrines, and did not trespass on the living area. This is not the place to discuss whether or how far such conditions are unavoidable: one has to accept the historical position and examine the results.

Now it is quite evident that in these two bodies of men, the influence of these local conditions must have been greater on the Ladysmith garrison. In the first place, the area was largely, if not entirely, infected from the first; it was in continuous occupation; and lastly, was comparatively limited in extent. Any limited area of a line of defence of which the importance necessitates its constant occupation, in conjunction with a system of reliefs, becomes a focus of infection for a large proportion of the defending force. Hence even supposing that the infected area is at first small, the ultimate result will be a widespread infection, first of the troops providing reliefs for this area, and later, through them, of the rest of the garrison, and the whole area. Such conditions obtained in Ladysmith, leading to the extreme prevalence which was observed during the siege.

Similar conditions were operative in the field army, but to a more limited extent. Here the troops were not confined to a limited area, but, on the other hand, were moving over comparatively fresh ground, that is, ground which may have been, and probably was, in parts infected, but which was certainly much less so than that occupied by the garrison of Ladysmith. The conditions under which excreta were disposed of were also less calculated to spread disease, in that for the greater part of the period under review the troops were in constant movement, and their exposure to any definite focus of infection was limited in duration, as they moved away from it.

(iv.) *The Mean Incubation Periods of Enteric Fever and Dysentery.*—These are variable and difficult to determine in practice. Curschman gives, "according to my experience—from one to two or three weeks," for enteric fever; the Clinical Society, "eight to fourteen days, sometimes twenty-three." These data relate to the occurrence in Europe. Martin[1] points out that the information regarding the incubation period in the Tropics is even less definite than that relating to European cases, and suggests that the *amount and virulence* of the infection has some considerable influence on the period. In Natal, such evidence as was available pointed to a period of about ten days. The incubation period of bacillary dysentery is shorter. Rüge gives two to eight days; this is longer than the period given by others. Strong and Musgrave give only forty-eight hours; in an experimental infection of man effected by

[1] Mense, "Handbuch der Tropenkrankheiten."

these authors, the period was but twenty-four hours. Lentz allows two to three days.

The important point is that whatever limits may be selected, the incubation period of dysentery is considerably shorter than that of enteric fever, and the harvest of cases following infection from a focus appears earlier and increases more rapidly. This is shown in the earlier development of the prevalence in the groups under consideration.

D.

One may now compare these two outbreaks in some detail, and this leads to the following conclusions :—

(1) The prevalence in Ladysmith was (except in the case of all bowel complaints) absolutely greater than in the Army in Southern Natal, and much greater relatively to strength, as is shown by the following table, in which the approximate ratios per thousand of strength are compared for the first fifteen weeks of the outbreak in each case, all that the figures permit. These have not been converted into annual ratios.

Continued Fevers.

Group	Admissions	Approximate ratio per 1,000
Ladysmith	1,242	98
S. Natal	1,095	47
Dysentery.		
Ladysmith	1,277	100
S. Natal	1,302	56
All Bowel Complaints.		
Ladysmith	1,381	109
S. Natal	1,969	85

As has been pointed out before, the Ladysmith rates are probably underestimated, while those in Southern Natal are probably too great. It will be noticed that bowel complaints other than dysentery accounted for only 9 per 1,000 in Ladysmith, but for 29 per 1,000 in Southern Natal. The term "S. Natal" includes little beyond the field army.

(2) The general features of each outbreak are similar.

One should compare only the first fifteen weeks in each case, as after the relief, the differentiation between the two groups becomes impossible.

In each body of men we find a much earlier outbreak and a more rapid development of bowel complaints than of fevers. The rapidity of development is indeed more marked in the field army, but on the other hand, having reached a certain degree of prevalence, the curve shows a series of oscillations above and below a mean, from which it does not widely depart till the last week of the period. In Ladysmith, on the other hand, we find a steady development to a maxi-

mum, followed by a very material fall, and again by a rapid and almost continuous rise to a second maximum.

(3) Dysentery and diarrhœa.

These constitute practically the whole of the cases returned as bowel complaints. In addition, forty-two cases of inflammation of the intestines were recorded in Ladysmith, and eight in the field army; these are included in the totals.

In each group dysentery was more prominent during the earlier weeks, diarrhœa became relatively more frequent as time went on. This is especially the case in Ladysmith, where dysentery practically accounts for the whole of the bowel complaints up to the middle of January, and it was indeed about this time that diarrhœa became more important in the field army also. How much reliance is to be placed on the distinction between diarrhœa and dysentery it is impossible to say. It is probable that a proportion of the total cases of diarrhœa were the sequelæ of antecedent dysentery, that in fact, one and the same individual probably figured among the dysentery cases first and the diarrhœa cases later; the converse probably also happened. But on the whole, the cases of bowel complaint which preceded in time those of fever tended to be diagnosed dysentery and not diarrhœa. In Ladysmith, indeed, up to the end of January, diarrhœa was extraordinarily rare. The recorded cases of diarrhœa do not of course represent all that actually occurred, but only those of sufficient severity to be admitted to hospital, and in Ladysmith hospital accommodation was limited.

Dysentery, of course, differs from enteric fever in that it is a recurrent and chronic disease, and the bare statistics afford no measure of the proportion of fresh attacks among the cases admitted to hospital. When, as in Ladysmith, so large a proportion of the population had been exposed to previous infection in India (setting aside the smaller possibility of the Natal troops having been similarly exposed to a less virulent infection), we should expect under normal peace conditions in Natal to have a certain number of admissions to hospital on account of previously contracted disease. Hence the admission curve for dysentery represents a condition differing from that shown in the admission curve for enteric fever, a combination of fresh and chronic cases as against fresh cases alone. Further, the relapse in chronic dysentery is more determined by climatic influences and by diet than is the infection of enteric fever.

(4) Coincidence in time between disease prevalence in the two groups.

The only striking features are the fall in fevers towards the end of February, and the rise in bowel complaints about the same time. There is a curious similarity between the two curves

for bowel complaints from the beginning of February onwards, and the coincidence of a rise in bowel complaints with a fall in fevers in both bodies of men is interesting. There was, of course, a great increase in the fevers (especially in those recorded as enteric fever) in the field army after the relief, but it is not now possible to extract materials to continue this enquiry after that date. It may, however, be the case that this increase in the bowel complaints was preliminary to the increase in the continued fevers in the middle of March, an increase which was less marked in the garrison of Ladysmith because of the small proportion of men left unattacked, in whom a diarrhœa may possibly have been the sole reaction after a typhoid infection. That there were variations in infectivity in Ladysmith is seen from the shape of the curves.

It is, however, hardly legitimate to draw any conclusions from the rough, unadjusted curves, and it is possible that all the variations may be without significance, either in one curve taken alone, or still more in the comparison of the two.

CHAPTER VII.

(8) The Development on the Western Line.

The heading of this section is perhaps misleading. Epidemic disease was prevalent to a considerable extent on the Western line —*i.e.*, the line from De Aar to Kimberley—but the chief interest of this prevalence lies in that it was in all probability the precursor of the far more important epidemic in Bloemfontein, and possibly even of that in Kroonstadt. Hence, the story, beginning on the Western line, will be carried on to include the Bloemfontein outbreak.

(i.) *The Military History of the Area concerned* may be summarised as follows : from the beginning of the War, De Aar and Orange River were occupied by small bodies of troops. Lord Methuen's force concentrated at Orange River in the week preceding November 20th ; the advance to Kimberley began on the 22nd ; the battles of Belmont, Enslin, and Modder River took place on November 23rd, 25th, and 28th respectively. From that date till the battle of Magersfontein, December 11th, and after that date, Lord Methuen remained in entrenched camp at Modder River. During December the number of troops on the line between De Aar and Modder River was largely increased. Then followed (between January 28th and February 12th) the concentration of troops for the advance at various stations on the line south of Modder River. From February 11th to 13th various bodies of troops advanced into the Free State. Paardeberg was invested on February 17th, and operations continued there till the 27th. The main army, under Lord Roberts, concentrated at Osfontein on March 6th, and the advance to Bloemfontein began the following day.

Our weekly returns cut the period at March 9th, the date of the last return before Bloemfontein was reached, which fits in conveniently with the final division of the troops of the advancing force from those on the Western line. During the operations in the Free State, prior to the advance from Osfontein, sick were sent to the hospitals on the Western line from the field hospitals with the advancing force, but this ceased with the departure from Osfontein. Hence, up to that date, some of the sickness was recorded on the Western line, and not with the main army.

(ii.) *Approximate Strengths* :—

At De Aar and Orange River on	13.10.99 ..	2,200 ..	App. 7, R.W.C.
,, Belmont	23.11.99 ..	9,666 ..	Offic. Hist., i., App. 6.
,, Modder River	28.11.99 ..	10,066 ..	,, ,, ,,
,, Magersfontein	11.12.99 ..	14,459 ..	,, ,, ,,
On the L. of C. (additional to Lord Methuen)	20.12.99 ..	11,000 ..	*Times* Hist., iii., p. 110.
Detrained	28.1.00—11.2.00 ..	30,000 ..	Offic. Hist.
Including 1st Division (not including L. of C.)	16.2.00 ..	41,000 ..	,, p. 337.
Main Army	6.3.00 ..	32,297 ..	Offic. Hist., ii., p. 190.
,, at Bloemfontein ..	13.3.00 ..	32,549 ..	,, ii., App. 6.
Advance to Pretoria	3.5.00 ..	.. ..	
Main Army		23,732	
Two columns		17,931	41,663 ,, iii., App. 2.

It is impossible to ascertain the average monthly strengths for the period, but from the figures given above we may form some rough idea of the average total strength of the troops sending their sick to the Western line :—

October ..	1,300	December ..	20,000	February ..	over 50,000
November ..	2,000	January ..	25,000		

It is most important to note that in the main army which left the Western line for Bloemfontein, the Guards Brigade had been exposed to infection since the first appearance of disease; the whole of the 19th Brigade and three-fourths of the 18th had been exposed on the Western line since the middle of December—that is, during the development of the outbreak—so that over 10,000 men, or rather less than a third of the main army, had been exposed to prolonged infection before entering the Free State.

(iii.) *The Composition of the Units.*—Most contained a large proportion of Reservists, ranging from 40 per cent. in the 6th Division to 52 per cent. in the 7th. The force under Lord Roberts contained at least 3,000 of South African and Oversea Colonials, so that it was, on the whole, well seasoned with "salted" men. The 7th Division arrived in South Africa between January 23rd and February 3rd, and went direct to the Western line :—

(iv.) *General Hygienic Conditions* :—

(*a*) *The Topographical and Climatic Conditions* were not favourable. Unlike Natal, the general characters of the area are those of an arid, treeless plain, broken by kopjies and dongas, very dusty, and reflecting all the incident heat. Over the whole of this area the mean maximum and wet bulb temperatures are relatively high, even in South Africa; the heat and dust were excessive during the advance, and especially during the earlier operations in the Free State. During the whole period there were frequent thunder-storms accompanied by torrential rain, from which the men (during the operations in the Free State at least), in bivouacs, and at times with only their great-coats, suffered severely.

(*b*) *Food Supplies.*—After the loss of the convoy at Waterval Drift on February 15th, the men received only half rations of groceries and bread till March 1st; from this date three-quarter rations. Meat was always plentiful, and an extra quantity was issued with the idea of compensating for the deficiency in the other items. But from supply difficulties and the nature of the earlier operations in the Free State, it then happened that bodies of men remained without food for comparatively long intervals. The difficulty of procuring firewood, too, complicated this question. In Bloemfontein there was a considerable shortage of food till April 7th, and to a less degree till April 17th.

(*c*) *Water Supply.*—This was usually bad, though some was better than others. Lord Methuen's force, and, indeed, a large proportion of the troops on the line or concentrated on it temporarily, depended mainly on the water of the Modder and Riet Rivers, which was thick, muddy, and liable to contamination. The fine, slimy mud clogged the filters which some units had, and at the best rendered their output small and slow, while often they could not be used at all. Treatment with alum resulted in some slight improvement, and boiling was also used as a means of purification, but to a limited extent from the want of fuel. At Modder River, a few shallow wells, sunk about 30 feet from the river bank, gave water that was a little better than that taken direct from the river.

On the line away from the rivers the quantity was limited; the source was from wells. During February nine boreholes were put down between Orange and Modder River by the Cape Government for the military authorities. Of these, five were successful: one gave 6,000, one 8,000, and three 11,500 gallons per diem, sufficient for small bodies of troops. The other four were abandoned at comparatively small depths, owing to the presence of hard rock. These bores were used for the troops on the line and during the concentration. The water was good.

But water difficulties really became serious on the advance into the Free State. The supply was scanty, so much so that the line of advance was to some extent determined by the channels of the Riet and Modder Rivers. There was a spring at Osfontein of limited output, otherwise the supply was from dams. When possible, the Royal Engineers went forward and laid down a length of hose and a hand pump, but the water was naturally foul, and deteriorated by the watering of horses and transport animals rendered uncontrollable by thirst. So long as the army was in touch with the rivers the supply was drawn from them, and notably at Paardeberg, where one section of the force drew its water from the river below the Boer laager, where it was highly contaminated.

Bloemfontein, before our occupation, had a double supply; one, incomplete and not compulsory, from the water-works at Sanna's Post (some 21 miles east of the town), where water was taken from the Modder, pumped through two reservoirs, one of which was provided with a sort of filtering arrangement, and distributed to the town in pipes. The process of purification was inefficient, but the supply, on the whole, was probably better than the alternative, that from wells in and around the town. On our arrival the water supply had been cut off,[1] but the water-works were occupied by us immediately after. On April 3rd the supply was again cut off by the Boers, and it was not till May 10th that the supply to the town was resumed. On April 16th a borehole at Sussex Hill was completed, giving 12,000 gallons per diem, and supplying the troops stationed there. By April 27th a bore at the Willow Trees was completed, with a daily yield of 96,000 gallons. This supply was forced into the town mains, and distributed to various camps. Three old bores in the same neighbourhood were cleared out and enlarged between May 8th and 28th, giving a total daily yield of 61,000 gallons; these supplied the hospitals and camp close to them. On May 27th a bore, giving 8,400 gallons, was opened in the camp of the 9th Division. Beyond the radius within which these various boreholes were practically accessible by water-carts and otherwise, the old, shallow, and, generally speaking, badly-protected wells were in use.

It will be seen, then, that no general statement can be made regarding the water supply of the whole of the troops for the whole of the time. During March the supply was from the water-works and wells; for twenty-three days in April (except on Sussex Hill) it was from wells alone, and from the end of April from boreholes and water-works, with probably a few remaining wells. Hence the worst period as regards water supply was undoubtedly between April 4th and 27th, while during May the conditions were improving. As to the quality of the supply, the best came from the boreholes (this was pure at the source), the worst from the wells (this was almost certainly contaminated). The water-works supply had been somewhat improved, and may have been pure at the distribution points, the stand-pipes in the town and camps.

(*d*) *The Sanitary Conditions.*—The condition of the camps on the Western line was not good. Owing to the small depth of soil, the latrine trenches were not satisfactory; for the same reason the burial of the bodies of horses and transport animals was not all that could be desired. The numerous small channels leading to

[1] "Official History," ii., p. 259.

the river allowed of pollution by natives and others, and the dryness of the soil, combined with a prevalent wind and not infrequent dust-storms, rendered the dissemination of infective material easy; on the other hand, the heavy rainfall swept all the *débris* into the river. Hence the infection of the soil which took place was carried to food supplies and water. These conditions were most marked at Modder River camp.

The conditions at Paardeberg, where the main army remained from February 18th to 28th, were even less satisfactory. There was, from the nature of the operations, a fouling of the ground which could hardly be avoided; sanitary arrangements could only be of the most primitive type, and the river water, at least below the laager, was much contaminated. The actual march from Osfontein to Bloemfontein was carried out under less unfavourable conditions, as the troops were constantly moving.

In Bloemfontein itself, a pail system of removal had been organised some few years before the War: before this a certain proportion of houses had cesspools attached to them. It does not appear to have differed in any essential respect from other towns of its class in South Africa, of which the general conditions have been already described (pp. 22 *et sqq.*). On March 15th orders were issued for the construction of latrines, and for the removal of night-soil and refuse daily. The execution of this plan naturally took some little time, but the trench latrines, which had of necessity to be employed at first, were gradually replaced by the relatively more satisfactory pail system. This system is of course defective in many ways, particularly in a subtropical climate, and with a widespread specific infection, it is probably an active agent in dissemination. There should be no difficulty in disposing with safety of all the infective excreta from a recognised case—*i.e.*, one in hospital—but it is difficult to see how excreta from cases in the preliminary stage, which do not come under observation, are to be dealt with.

The conditions during the halt at Bloemfontein varied almost from day to day. Bodies of troops of various strengths were constantly coming and going; drafts began to arrive; remounts were brought up in great numbers; transport animals were brought in, the whole of this involving temporary camps and some dislocation of the existing sanitary scheme. Further, the rainy season, now at its maximum, made clean sanitation more difficult.

One may say that, as regards the whole period, from the arrival of Lord Methuen's force at Orange River to the time of the advance to Pretoria, every one of those conditions to which the origin or spread of enteric fever may be due, existed and were active: polluted water, infection of food by water, flies, or dust, the presence of young soldiers fresh from England, and (from the

date of advance of the main army) of a large number of infected units, amounting to a total of 10,000 men. Every possible condition existed to favour the development of an epidemic, and the results did not contradict previous experience. From the time of the occupation, there was a steady improvement in the sanitary conditions in Bloemfontein in every respect, somewhat interrupted in the case of the water supply (as detailed above) and the general sanitation, and after the termination of the outbreak, which may be taken to be the end of July, 1900, Bloemfontein did not in fact show itself to be an unhealthy town.

(*e*) *Disease History of the Area Concerned.*—As regards the Western line, a general indication of the conditions in the Colony has already been given (pp. 22 *et sqq.*), to which it only remains to add that in Kimberley repeated outbreaks of enteric fever and dysentery were common. Modder River was probably involved in this infection. During our operations sporadic cases had been seen among the Boer Commandoes before Kimberley in the last week of November, and in December a well-marked outbreak began. These cases were sent to hospital at Jacobsdal, situated on the Riet River and draining into it; this may have affected our camp at Modder River, as it was in the fork at the junction of these two streams. The sanitary condition of the positions occupied by the Boers was as bad as possible; this affected the camp at Modder River and the forces passing over these positions in the advance.

Bloemfontein had been subject to annual outbreaks of enteric fever and dysentery; it was on these grounds that expenditure on the water-works was undertaken. It was said that the prevalence of these diseases had diminished during the last years before the war; if so, this was an exception to the general condition in South Africa, where enteric fever had increased, or had been more frequently recognised. There had certainly been an increase in the townlets and farms surrounding Bloemfontein, with which our troops had been in contact. As elsewhere, the prevalence occurs during the *summer* rains, which in Bloemfontein are prolonged over the first quarter of the year; the maximum rainfall occurs in March, while in April and May 10 per cent. and 5 per cent. respectively of the total rainfall occur. Our occupation began at about the apex of the rainy season. Hence, taking the annual prevalence in conjunction with the rainy season, there seems no reason to doubt that the whole of Bloemfontein was an infected area.

(v.) *The General Incidence of Disease.*

(*a*) The development of the continued fevers and bowel complaints is shown in the first part of fig. 10, drawn from the weekly

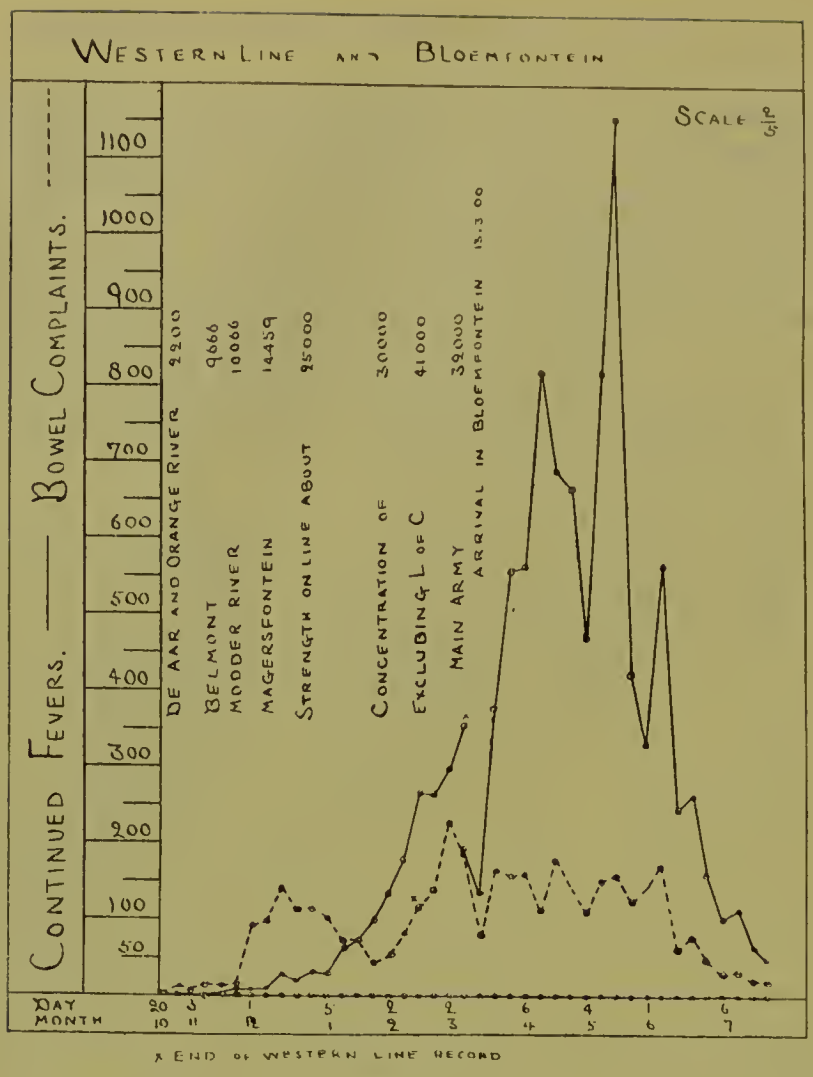
WESTERN LINE AND BLOEMFONTEIN
SCALE 1/5
CONTINUED FEVERS. —— BOWEL COMPLAINTS. ------
1100
1000
900
800
700
600
500
400
300
200
100
50
DE AAR AND ORANGE RIVER 2200
BELMONT 9666
MODDER RIVER 10066
MAGERSFONTEIN 14459
STRENGTH ON LINE ABOUT 25000
CONCENTRATION OF 30000
EXCLUSIVE OF C 41000
MAIN ARMY 39000
ARRIVAL IN BLOEMFONTEIN 13.3.00
DAY
MONTH
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9
10 11 12 1 2 3
X END OF WESTERN LINE RECORD

FIG. 10.

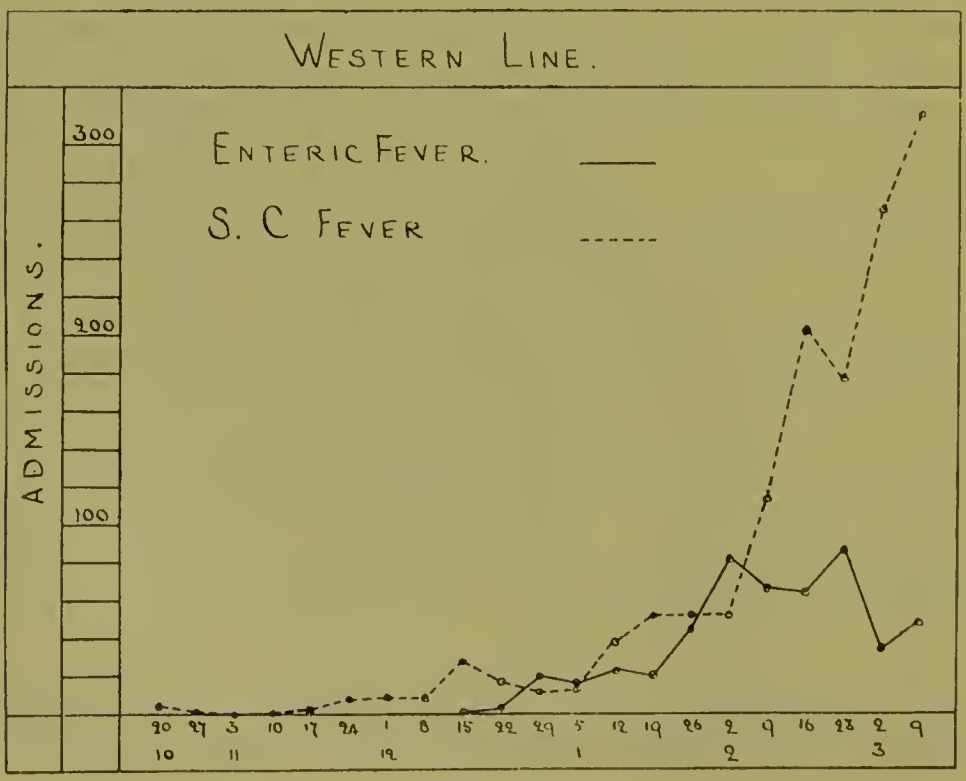
WESTERN LINE.
ENTERIC FEVER. ——
S. C FEVER ------
ADMISSIONS.
300
200
100
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9
10 11 12 1 2 3

FIG. 11.

admissions throughout the periods. It is obvious that the curve is compound, unlike those for Ladysmith and South Natal, since there were large and important increments of strength during the period as noted above. But the general curve shows this sufficiently well, while the details can be seen more distinctly in fig. 11, showing the dissection of the continued fevers, and fig. 12, of the bowel complaints to March 9th, 1900, while fig. 13 is devoted to Bloemfontein itself.

It will be sufficient to give the numbers relating to each station, with some notes on their relations to one another.

The total cases between October 20th, 1899, and July 27th, 1900, were :—

			Total
Enteric fever	Cases 5,459	Deaths 1,069	
Simple continued fever	,, 4,982	,, 3	10,441 cases, 1,072 deaths
Dysentery	,, 1,855	,, 89	
Diarrhœa, &c.	,, 1,964	,, —	3,819 ,, 89 ,,

giving case mortalities as follows : Enteric fever, 19·6 per cent. ; all continued fevers, 10·3 per cent. ; dysentery, 4·8 per cent. ; all bowel complaints, 2·3 per cent.

(*b*) Dividing the period at March 9th, we obtain the following figures for comparison :—

		Enteric fever	Simple continued fever	All continued fevers
Western Line ..	Cases	500 ..	1,373 ..	1,873
	Deaths[1] ..	108 ..	— ..	108
	Case mortality	21·6 per cent.	— ..	5·8 per cent.
Bloemfontein ..	Cases	4,959 ..	3,609 ..	8,568
	Deaths ..	961 ..	3 ..	964
	Case mortality	19·4 per cent.	— ..	11·25 per cent.
		Dysentery	Diarrhœa, &c.	All bowel complaints
Western Line ..	Cases	718 ..	980 ..	1,698
	Deaths	8 ..	— ..	8
	Case mortality	1·1 per cent.	— ..	0·47 per cent.
Bloemfontein ..	Cases	1,137 ..	984 ..	2,121
	Deaths	81 ..	— ..	81
	Case mortality	7·12 per cent.	— ..	3·82 per cent.

(*c*) *The Case Mortality of the Continued Fevers.*—We have now four groups to compare as regards case mortality (using this as an imperfect index of type), and it is more interesting if taken in relation to the proportion of all continued fevers which were returned as simple continued fever :—

	Simple Continued Fever, per cent. All continued fevers	Case Mortality, per cent. Enteric fever	Case Mortality, per cent. All continued fevers
Ladysmith	43 per cent. ..	28·13 ± 0·39 ..	16·00 ± 0·52
S. Natal	86 ,, ..	38·31 ± 2·65 ..	5·57 ± 0·47
Western Line ..	73 ,, ..	21·60 ± 1·24 ..	5·76 ± 0·36
Bloemfontein ..	42 ,, ..	19·38 ± 0·38 ..	11·25 ± 0·16
Whole war	36 ,, ..	13·91 ± 0·10 ..	8·87 ± 0·06

[1] Of these, 35 (one-third) occurred between February 16, 1900, and March 9, 1900.

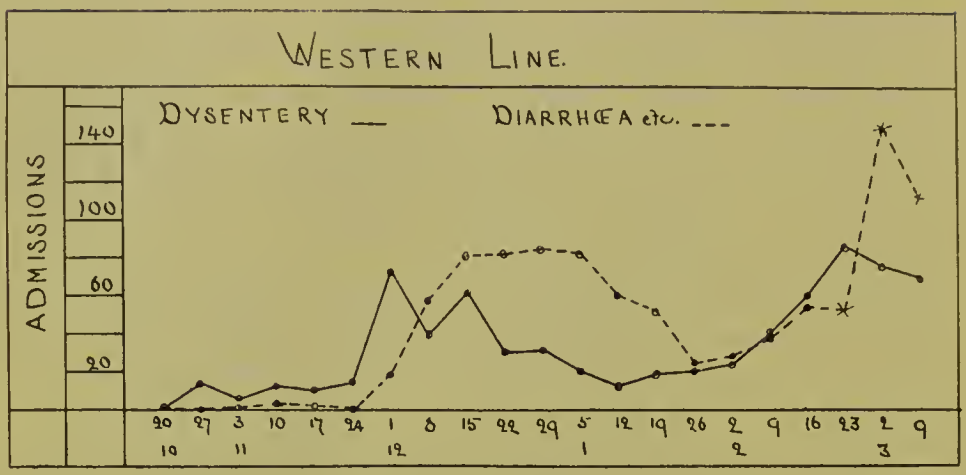
WESTERN LINE.
ADMISSIONS
140
100
60
20
DYSENTERY
DIARRHŒA etc.
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9
10 11 12 1 2 3

FIG. 12.

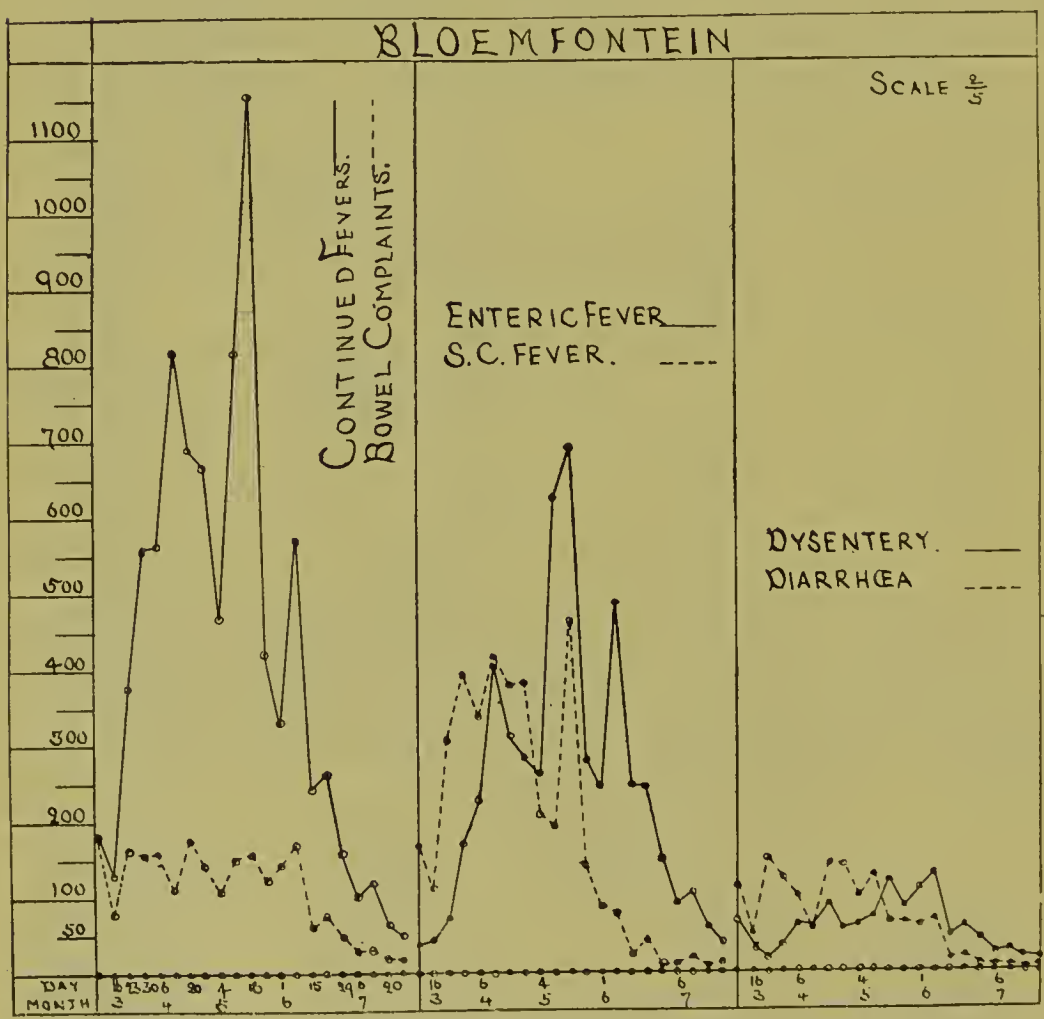
BLOEMFONTEIN
SCALE 2/5
1100
1000
900
800
700
600
500
400
300
200
100
50
CONTINUED FEVERS.
BOWEL COMPLAINTS.
ENTERIC FEVER
S.C. FEVER.
DYSENTERY.
DIARRHŒA
DAY
MONTH

FIG. 13.

The deaths recorded from the Western line and Bloemfontein do not represent all that occurred among the cases treated there; some cases were transferred to hospitals outside the area, such as Deelfontein and the hospitals near Capetown, and to Springfontein, for a part of the period. Hence, at least on the Western line, the case mortality is underestimated.

The case mortality for enteric fever in South Natal is so excessive that it indicates a different standard of diagnosis from that obtaining elsewhere. Ladysmith shows a higher case mortality —*i.e.*, a more severe type—than any other group. The two field groups are indistinguishable. The Western line shows some under-diagnosis of enteric fever as compared with Bloemfontein, from the absence of any valid difference in the case of enteric fever, and the considerable difference in the case of the total of the continued fevers.

Now it is quite evident that, among these four groups, the higher the proportion of cases returned as simple continued fever, *the lower the case mortality for the whole group of continued fevers.* In South Natal and on the Western line the case mortality for all fevers was about half that in the other two groups. In both these cases the troops were on the move, more markedly so in Natal, but even on the Western line, the greater strength (in February and later) had a much greater degree of freedom than the groups in Ladysmith and Bloemfontein.

To an observer without preconceived ideas, this relation could only mean that simple continued fever was a disease possibly distinct from, but certainly having a much lower case mortality than enteric fever. At the present time, however, even more than at the time of the South African War, with increasing knowledge general opinion regards simple continued fever cases, occurring under the conditions which were associated with these outbreaks, as mild, larval, or abortive attacks of a typhoid affection, having normally no mortality, at least in the original attack. All evidence shows that this is probably correct in nearly every case. It is of the greatest importance, in relation to prevention, that the true nature of the cases should be recognised. On the other hand, it is equally important from the practical side, especially in war, that no case should be regarded as infective unless the probability, in the absence of valid evidence, is in favour of its infectivity. Incidentally these figures show that in all cases the better marked cases were diagnosed correctly from the first.

In the two groups in question (South Natal and the Western line) some proportion of the milder febrile cases may not have been due to infection by the typhoid group but to some other cause. In the case of the Western line, the extreme heat and

scarcity of water during the earlier operations in the Free State suggest a thermal influence, and, as a matter of history, of 372 cases admitted to hospital between October 13th, 1899, and March 31st, 1900, for "the effects of heat" (giving an admission-rate of 7·52 per 1,000 as against 2·28 for the rest of the campaign), 216 occurred on the Western line and 90 in Natal. Reports from field hospitals at this period showed that this was believed to be the cause, and that if transport had been available to carry on these men, they would have been able to return to duty within a few days. In both these cases, then, some part of the middle portion of the curve of prevalence may have been due to this cause. One must, however, for purposes of comparison (in South Africa) take the group of continued fevers to be homogeneous, and the time relations of the simple continued fever admissions to those for enteric fever undoubtedly suggest a common origin, in which case the explanation of the difference in severity may lie in variations in the virulence of the infection, the term "infection" including the individual bodily reaction as well as the pathological activity of the agent. Both in Ladysmith and Bloemfontein, conditions were such that a highly concentrated agent was probable, and in both the energies of the men had been sapped by exposure, fatigue, and privation, to a much higher degree in Ladysmith, however, which may partly be expressed in the greater case mortality of the whole class of continued fevers. In the more mobile force the proportion of mild infections was much greater.

(*d*) Similarly we may compare the proportion of diarrhœa, &c., to the total in the group of bowel complaints, in relation to the case mortalities :—

Group	Diarrhœa, &c., per cent. of all bowel complaints	Case Mortality Dysentery per cent.	Case Mortality All bowel complaints per cent.
Ladysmith	22	5·70 ± 0·36	4·42 ± 0·28
S. Natal	34	3·53 ± 0·35	2·54 ± 0·24
Western Line	58	1·11 ± 0·26	0·47 ± 0·11
Bloemfontein	46	7·12 ± 0·52	3·82 ± 0·28
Whole War	33	3·52 ± 0·06	2·40 ± 0·04

The figures from South Natal are practically identical with the average of the whole campaign. Bloemfontein shows a much greater proportion of (in name) non-dysenteric cases than Ladysmith, but the case mortalities for dysentery and for all bowel complaints do not, on the figures, differ distinctively. The Western line is the only group here which seems to differ from the others to any great extent—that is, in the great proportion of diarrhœa, which was one of the features of the occupation of that line. The case mortality from dysentery is exceedingly low, but some cases died outside the area, which would tend to raise this case mortality.

(*e*) It may be of some interest to add that these four groups include the following percentages of the total admissions under each head during the whole campaign :—

Enteric fever	12 per cent.	Dysentery	13 per cent.
Simple continued fever	21 ,,	Diarrhœa, &c.	15 ,,
All continued fevers ..	15 ,,	All bowel complaints ..	14 ,,

With the exception of simple continued fever, all these percentages are practically identical. Simple continued fever, then, was recorded less frequently after the conclusion of the periods included in these groups.

(*f*) Bearing in mind what has been said regarding the distribution of the troops and the approximate strengths on the Western line, it may be useful to indicate briefly the progress of disease at the various points on that line.

The period is from the date of occupation to March 9th, 1900 :—

Admissions.

De Aar—

Enteric fever	77	Dysentery	59
Simple continued fever ..	55	Diarrhœa, &c...	22
Total	132	Total	81

Here the admissions for bowel complaints were never statistically important. Simple-continued fever remained low throughout, and the first case of enteric fever was reported on December 15th, about the same time as in Orange and Modder River stations, in the civil population of Kimberley, and the Boer forces in front of it, though a few sporadic cases had already been recognized among the Boers. A large number of cases of both groups of disease were treated in the hospitals at De Aar, having been transferred from stations higher up the line.

Admissions.

Orange River—

Enteric fever	142	Dysentery	162
Simple continued fever ..	90	Diarrhœa, &c...	107
Total	232	Total	269

There was a small incidence of febrile disease from the very first, unimportant up to December 22nd, when the first case of enteric fever was reported. From that date there was a steady and considerable rise to the maximum in the last week in January (associated probably with the increased strength on the line), when there was a drop followed by another rise immediately before the advance into the Free State.

The admissions for bowel complaints, as has been seen in Natal, began to assume prominence earlier and attained their maximum development before the febrile diseases began to develop. Dysentery

was the first of these diseases to appear, and it was replaced later by attacks which were recorded as diarrhœa.

	Admissions.		
Modder River—			
Enteric fever	249	Dysentery	283
Simple continued fever ..	703	Diarrhœa, &c...	524*
Total	952	Total	807

* Does not include cases after February 16th.

A great development of bowel complaints occurred immediately after the occupation of Modder River. This development attained its maximum, and its decline was well established before the febrile diseases became important in the middle of December. This condition appears to have been definitely associated with the water supply, which contained so much fine mud that its filtration was practically impossible. Here diarrhœa, familiarly termed the "Modders," was the prominent feature at the outset, and throughout the period maintained its predominance, dysentery furnishing fewer cases and declining more rapidly. One does not of course expect to find figures for diarrhœa which represent the actual prevalence ; in many cases, the attacks were endured without any record in our statistics. We probably do not have on record more than half the cases that occurred, and this applies to every place in South Africa during the War.

Febrile disease began to be suggestively important soon after arrival at Modder River, and enteric fever, after maintaining a fairly steady incidence from the middle of December to the middle of January, increased rapidly, at which period, too, simple continued fever showed still greater development. Probably a large proportion of the cases were enteric fever, though some unknown proportion may have been due to other causes.

	Admissions.		
During the Early Operations in the Free State, February 9th to March 3rd.			
Enteric fever	32	Dysentery	201
Simple continued fever ..	520	Diarrhœa, &c...	327
Total	552	Total	528

Of the simple continued fever, 386 cases occurred between February 23rd and March 9th, and 260 of the diarrhœa cases occurred during the same period—that is, during the investment of Paardeberg and the few days prior to the advance. As has been shown above, probably some of the simple continued fever cases were due to the effects of heat.

The following account by Lieut.-Colonel G. Coutts, R.A.M.C., who was at Modder River, gives fuller details regarding the out-

break there, and some particulars regarding the results of the early operations in the Free State :—

"Lord Methuen's force, which numbered about 13,500 men, occupied a level plain enclosed by a wide bend of the Modder River on the East and South, rising gradually towards the entrenchments of the enemy, which were five miles distant. The soil was sand with some admixture of clay, overlying a compact bed of calcareous conglomerate. The scanty vegetation quickly disappeared with the traffic, leaving a surface of fine loose sand.

"The buildings which went to form Modder River consisted merely of the railway station and its attached administrative buildings, and the schools and dwelling-houses of the employés. In addition there were two hotels which in days before the war were supported by visitors from Kimberley. The division was encamped as follows: The Guards Brigade was located on the east side of the Modder, between it and the Riet; the 9th Brigade occupied ground on the east side of the railway; the Highland Brigade was on its western side; and between the Infantry and the river on both sides of the railway were the Cavalry, Artillery, Supply and Remount Depôts, &c. The Field Hospitals and Bearer Companies were encamped with the Brigades to which they were attached, and the Divisional Hospital in a central position.

"Drinking water was drawn for some time from the river. It was of a brown colour, full of suspended matter, and gave off gases when kept for a short time in a bottle. Various methods were adopted to purify it, as precipitation of suspended matter with alum, filtration through Berkefeld filters, and boiling. The latter was effected under difficulties, owing to the scarcity of fuel, the absence of suitable vessels for carrying out the process and for subsequent storage. On the whole, it is probable that this process was very ineffectively applied. Filtering was, with the Berkefeld filter, practically impossible without previous precipitation of the suspended matter; the filters quickly became blocked. After a time fairly deep wells were used, but the supply from them was hardly sufficient, and the water sometimes milky. The soldier was not greatly impressed with the necessity of purifying his drinking water; not infrequently men were discovered filling their water-bottles in the river at whatever point they happened to be nearest.

"The latrines were made in the usual form by each unit in a position best suited to its own part of the camp, with the result that considerable areas of the soil were soon polluted. This was assisted by the transport animals picketed with each unit. The soil had little deodorizing power, and disinfectants were not at first available.

"The weather was hot and for the most part rainless, and high

winds were frequent, often lasting the greater part of the day. They blew before them blinding clouds of dust, which rendered food gritty and filled one's nose, eyes, ears, and mouth, and carried latrine paper and other light bodies from one end of the camp to the other. Flies multiplied rapidly and were a great source of annoyance to both the sick and the healthy, besides acting as carriers of the disease.

"Enteric fever was first clearly recognised on December 18th. Almost from the first diarrhœa was frequent, so frequent as to acquire among laymen the name of 'Modders.' In a large number of cases it subsided after a few days' careful dieting and treatment. Dysentery was not a serious complaint. Commencing about the middle of December, 1899, enteric fever by the end of that month caused eighteen admissions to hospital, from nine different corps. This wide dissemination might appear to argue a water-borne origin, but the Guards, who took most pains to purify their drinking water, suffered most, whereas the Highland Brigade who were backward in adopting precautions, contributed their first case of enteric fever to the Stationary Hospital on January 12th, 1900. Their lines occupied the north-western corner of the camp, and the prevailing western winds blew diagonally across it from the open veldt. They did not therefore share in the dust from other camps to the same extent as the other units.

"On a review of the circumstances of this outbreak, therefore, it appears that the most probable cause was the infected dust derived from the latrines, and carried into food and drink by the wind. The influence of contaminated water cannot, it is true, be excluded; but, as was afterwards abundantly shown in the course of the war, men might be scrupulously careful about the quality of their drinking water and still contract the disease, and in this camp the regiments that took most care with their drinking water suffered rather more than the rest. This presupposes the existence of the germs in some parts of the camp, their ingestion and gradual increase, and the subsequent infection of the latrines by incipient or ambulatory cases; but it was a matter of common knowledge that a continued fever, sometimes called 'veldt fever,' was common among the inhabitants of the district at certain seasons. Between December 24th, 1899, and March 10th, 1900, there were 283 cases with 61 deaths, or a mortality of 21·55 per cent. This high percentage is partly accounted for by the fact that many of the milder cases were sent towards the base as simple continued fever, diarrhœa, &c., but many of the cases were very acute and ended fatally from toxæmia. Of this number, the Guards Brigade, 3,780 strong, contributed 48 admissions, with 14 deaths; the 9th Brigade, 2,839 strong, 53 admissions, with 12

deaths; and the Highland Brigade, 3,311 strong, 35 admissions, with 10 deaths. The Cavalry, with the exception of the 9th Lancers, which had been longest in the camp, were not severely attacked, but the Royal Artillery and the Departmental Corps suffered severely. The Royal Army Medical Corps had 26 cases and 3 deaths, but many of the attacks could be traced to attendance on the sick. The cases not belonging to the 1st Division were left behind by Lord Roberts's force, or were sent back from it by sick convoy. The Guards Brigade and the Highland Brigade accompanied this force, and continued to send back cases to Modder River or Kimberley until the force had left Osfontein. Amongst the sick convoys from Paardeberg and beyond, dysentery appeared to be more common than it had been at Modder River."

Admissions.

BLOEMFONTEIN—			
Enteric fever	4,959	Dysentery	1,137
Simple continued fever ..	3,609	Diarrhœa, &c.	984
Total	8,568	Total	2,121

The distribution of the cases is shown in fig. 13.

Dealing first with the curve for continued fevers, it shows three maxima separated by deep depressions. The first maximum, on April 13th, differs from the others, in that it probably represents *exclusively* the development in the main army which crossed from the Western line, for the railway was not in full working order till towards the end of April, and few troops entered Bloemfontein during the first half of that month. The probable incubation period, too, supports this hypothesis, assuming all the cases to be infections of the typhoid group. The sharp rise to the maximum began immediately after the occupation—about March 16th—or in the seventh or eighth week from January 26th—*i.e.*, approximately from the date of the concentration on the line for the advance to Bloemfontein. The two other maxima—of May 18th and June 8th—are in a different category. The body of troops in which the cases occurred cannot be described simply and accurately, and accordingly time relationships are obscured. That they were due to new infection, partly among freshly arrived troops, superadded to a declining prevalence among the older residents, is probable, for the general character of the curve from April 13th to the end of the period is suggestive of a gradual fall, although interrupted by these short and sharp rises. It is perhaps worth noting that, while the first maximum required at least four weeks for its development, the obvious rise of the second maximum lasted only two weeks, and of the third only one week—*i.e.*, the actual development is obscured by the antecedent prevalence. There are

great difficulties in the way of ascertaining the actual distribution of the cases among the troops and their relation to the strength, and it is quite possible that the true prevalence curve would not show this division into three parts, but a steady rise and fall to and from a single maximum. This, however, would not necessarily interfere with the composite nature of the curve, which we know must in fact be the case, although, instead of three, there may be many elements, nor would it have any effect on the assumption that the first maximum is the culminating point of the development in the main army, which began about the date of concentration on the Western line. Doubtless the concentration of the rise in each of the two later maxima has something in it that suggests a widespread infection over a comparatively short period of time, where a number of cases, infected together, matured about the same dates. It might be the case that the maximum of May 18th was the apex of an epidemic of short development, due to the use of contaminated water from wells, but this at the most would not carry the origin back beyond the last week in April, when the only important event in connection with the water supply was the forcing into the town mains (which had been disused since April 3rd) of the excellent water from the borehole at the Willows. There is no reason to suspect any contamination of the mains such as would be necessary to produce a widespread infection of this type. It is important to remember that a concentration of troops had taken place in and near Bloemfontein on May 3rd, and that the sick were sent back daily by rail till the occupation of Kroonstadt on May 12th. This probably did account for a portion of the increase in the *admissions* about this date,[1] as men held on in the hope of the advance as long as they could, but it hardly helps in explaining the origin of the cases.

It is even more difficult, practically impossible, to trace any connection between the smaller maximum of June 8th and any other known condition. Indeed, from the end of April the conditions had steadily improved. The sanitary condition of Bloemfontein had become distinctly better, food supplies were no longer short, tents and blankets had been brought up, the water supply had been improved, the camps of the Sixth Division had been changed, while most of the other troops had been outside of the town area for a portion of the time. The weather, too, was improving; usually fine, it was cold at night and especially in the early morning. The various sources of infection no doubt still existed, but it is hard to believe that, after all that had been done, these can either have been so frequent or so intense. It

[1] See also p. 117.

must, however, be pointed out that this maximum is only three weeks later than that of May 18th, which may indicate some direct infection.

The dissection of the continued-fever curve into its elements does not elucidate the question in any way, but it shows very distinctly the change of opinion, or of fashion, in the diagnosis of these fevers from the middle of May, a change that had no basis in any variation in the type of disease. There is little doubt that during the first half of the period enteric fever was not diagnosed frequently enough—the milder cases were returned as simple continued fever—but during the latter half there is little question that cases were returned as enteric fever which in all probability were not of that type at all.

As regards the bowel complaints, the striking feature is the oscillation about a mean level until the second week in June, so reproducing the features seen in the Natal Field Army. During the first half of the occupation, dysentery is seen to be less frequent than diarrhœa, while the relations were reversed during the last half. No explanation of this change can be given, if it was in fact real, and not merely diagnostic.

CHAPTER VIII.

The Mode of Development of an Epidemic.

(vi) We are now in a position to consider *the development as a whole from October*, 1899, *to July 27th*, 1900, *of the continued fevers and bowel complaints as they occurred on the western line and in Bloemfontein*, in conjunction with the conditions observed in Natal.

(*a*) The bowel complaints may be dismissed in a few words. While the troops were in occupation of the line, or in touch with it, that is till about March 9th, the distribution curve (fig. 10) shows the very great sensitiveness to an addition to strength. The sudden rise in the week ending November 29th coincides with Lord Methuen's concentration; the rise from the week ending January 26th coincides with the concentration for the advance into the Free State. After this, the condition, as has been pointed out, is one of comparatively small oscillations (of a period of approximately two weeks) about a mean level; there is no attempt at the production of a definite maximum, and the whole character of the distribution is in marked contrast to that of the continued fevers, with which the only point of similarity lies in the descent from June 8th. This is exactly the condition seen in the Natal Field Army. Further remarks on the relation between the early bowel complaints and fevers will be found at the end of this section.

It may be noted here that throughout the War the admissions for dysentery varied less from month to month than did those for enteric fever. The annual range was less, and the seasonal influence less distinct (see fig. 14).

(*b*) Instead of considering the development of the continued fevers on the Western line and in Bloemfontein alone, it is more convenient to take them along with those already described in the garrison of Ladysmith and the Natal Field Army, in the endeavour to ascertain what common features they have, and what is to be learned from them in relation to prevention.

There are two possible views as to the manner in which these and similar epidemics arise. One may be termed the hypothesis of *infection from without*, mass infection, the second that of *infection from within*, or, shortly, auto-infection. Infection from without, or infection in the mass, is taken to mean the infection

of a body of men by a general source outside of and previously unconnected with that body; it has, therefore, a definite date of commencement, and if investigations can be pursued far enough, this date can be correlated with exposure to some known source of infection. One may take as an example an exclusively water-borne epidemic, such as that at Worthing. Internal auto-infection is taken to mean the gradual and, at last, general infection of a body of men of whom a *comparatively small number* are already infective (carriers), or have become infected by some external source. The characters of mass infection are well known: the sudden occurrence of a large number of cases after an interval of about the normal incubation period from the date of infection, followed by a more gradual decline. Auto-infection takes a different form: the first few cases form fresh foci, and with the normal incubation period determining the intervals, the progress and multiplication of cases should be of the type of a geometrical progression, which, however, in practice is always and fortunately limited in the number of its terms, presumably by the inequality in susceptibility in the persons exposed, and by the exhaustion of the susceptible population. Otherwise, it is difficult to see why such an outbreak should ever stop.

Now it is of considerable practical importance to ascertain how far one or other type will account for epidemics. Protection against infection in the mass is probably not impossible; sanitary measures which are comparatively simple and practicable can be carried out without difficulty. Auto-infection is much more difficult to deal with; it means the elimination of apparently healthy but infective individuals, of all the minor types of infection—diarrhœa, ephemeral fever, &c.; the isolation of the sick and convalescents (the latter probably permanently so far as the campaign is concerned), and, more difficult still on service, of contacts, besides the full and careful maintenance of all the sanitary measures which are organized for the protection of the force from infection from the outside. The distinction between these two types is not in practice absolute; a water epidemic, for example, begins as an external infection, but usually shows in the manner of its decline evidence of some degree of auto-infection, but the difference between the two types in the mode of development and the possibility of prevention is absolute.

For these reasons it appears to be useful to spend some time in considering the prevalence in the four groups which have been described. The materials allow only of the crudest method of treatment, but some results appear attainable which, if not absolutely accurate, are at least suggestive.

The epidemics in Ladysmith (the first part), South Natal and on

the Western line, show, when plotted, curves of the same type (figs. 5, 7, and 10). They show a maximum, termed for convenience "the apex," a portion which would not be inadequately represented by a straight line, separated from an earlier, more irregular, portion by a sudden change of curvature. Each one of these irregular polygons as plotted can be fairly represented by a continuous curve drawn from the same template, and in each the earlier irregular portion shows an incidence less than that shown by the continuous curve.

Now the dates at which the exposure of the respective bodies of men began are known, the dates of the maxima are available (except on the Western line), and the date on which the straight line portion began may be determined by inspection of the diagram with comparative accuracy. Tabulating these results we find a close agreement :—

Group	Beginning of straight line	Apex
Ladysmith	In 8th week	11th to 12th week.
S. Natal	,, ...	12th week.
W. Line	About 8th week	(?)

The weeks are counted from the date of exposure.

It appears to be justifiable to take as a working hypothesis that the period of invasion of the epidemic is about eight weeks, or more than twice any possible individual incubation period, and that it takes about four weeks longer to attain its maximum.

We can now attempt to apply this hypothesis to the case of the epidemic in Bloemfontein. The first maximum there—that of April 13th—conforms to the conditions seen above, the beginning of the straight line portion is in the eighth week from January 26th, and the apex is twelve weeks from the same date. That date is practically the beginning of the concentration period on the Western line. The next two apices are less easy to deal with. Their relation to possible external causes has already been spoken of, and it has been seen that it is difficult to trace any connection between them and any definite and known source of infection, widespread but of limited duration—a condition which is required to explain the short period of development of these maxima.

Now if we take the figures for the prevalence in South Natal, and eliminating the irregularities by taking the means of every two successive weeks instead of the actual numbers for these weeks, if we add the same series of numbers *twice* to the original set, at intervals corresponding to the intervals between the maxima in Bloemfontein, and then plot the resulting series of figures, we obtain a curve of the same general character as that in Bloemfontein, with three maxima separated by deep gaps. There are, however, certain important differences, which are due to the character of the Natal curve, which shows only a very short period of decline.

This is of course a very crude method, but it suffices to show that three similar but independent epidemics superposed will produce a curve of the characters shown, without any necessity for the assumption of specific instances of widespread infection at definite times, and it points to the gradual development of each epidemic in the same way as is seen in the Natal groups described above. The differences seem to show that in all probability the growth of the second and third epidemics, superposed on that beginning on the Western line, was rather more rapid than in the cases shown above. This is *a priori* probable, as the chances of infection increased with the number of troops brought into the area, and the opportunities for infection were multiplying rapidly during March and probably April, so that one might expect to find the number of cases increasing more rapidly than in the earlier epidemics, because of the greater number of foci introduced into the group.

We can now consider the probabilities regarding the two later maxima. In both the origin of straight line portion of the hypothetical curve is obscured, but in the examples already given the apex has been found to have a fairly constant relation to the origin. Hence, in relation to the maximum of May 18th, the earliest possible date for the origin is February 23rd, towards the end of the investment at Paardeberg. This agrees well with the known conditions, but the suggestion of a shortened development may place the origin actually in the early days of the occupation of Bloemfontein. As regards the maximum of June 8th, the earliest possible date for the origin is March 16th, so that this outbreak certainly originated in Bloemfontein. Summing up the possibilities under the two heads, external infection and auto-infection, and indicating the epidemics by the dates of their maxima, we find :—

April 13 ..	External infection ..	Not earlier than February 23, at Paardeberg.
,, 13 ..	Auto-infection ..	Continuous development from tho Western line.
May 18 ..	External infection ..	Not earlier than mid-April.
,, 18 ..	Auto-infection ..	Possibly Paardeberg ; probably Bloemfontein in the early days.
June 8 ..	External infection ..	About middle of May.
,, 8 ..	Auto-infeetion ..	Soon after occupation of Bloemfontein.

Either hypothesis will conform with the actual conditions, except that, as pointed out above, there are difficulties in pointing out *special* intensities of infection which seem necessary for the explanation of the sudden sharp rises of the two later maxima. Auto-infection places the origin, *i.e.*, the first cases and the limited early infection, considerably earlier than external infection—the

infection of considerable numbers. The actual dates of infection are of no moment; what is important is to ascertain, if possible, whether mass infection (which can with great care be prevented) is the effective agent, or whether the slower, less definite and much more intractable, gradual infection of the whole mass from the infection and infectivity of small numbers is in practice not only possible but probable. The summary shows that if a full incubation period of about three weeks is allowed, the infection which determined the epidemic of April 13th may have taken place at Paardeberg. But there seems little doubt that this particular epidemic was the result of continuous development from the Western line. Similarly, if we allow a three weeks' incubation for the epidemics culminating on May 18th and June 8th, the infection may be dated back to somewhere about the middle of April and of May respectively. The sudden rise in these two epidemics may represent the maturation of specific infection of large numbers, but from the very sharpness of the rise, if instances of specific infection were the cause, these infections must have been widespread, and of *limited duration*. They are of the type of a sudden general infection. Opportunities for infection were undoubtedly frequent; what is not known is the existence of a sudden increase in the intensity of the infection lasting but a short time.

Neither of the methods of development ever works alone; it is really a question of degree. But there is certainly sufficient evidence to show that the prevalence of specific febrile disease in the field is not determined alone, or even chiefly, by a mode of infection which may be prevented by what are ordinarily included under the term "sanitary precautions"—that is, by the provision of a pure water supply, which of itself will never stop its development, nor by the successful execution of the more difficult task of preventing the spread of infection from latrines and urinals, or their equivalents; that effective preventive measures involve the treatment of the specific fever, enteric fever, as if it were, as in fact it is, as easily spread, and by the same modes as any other member of the group. These effective preventive measures must include isolation and disinfection of the patients (both in the acute and convalescent stages), of the attendants and of all contacts; and those who have practical experience of war conditions, especially with a large native establishment in close relation to the troops, will easily recognize the difficulty of carrying out these measures, absolutely essential if disease of this type is to be eliminated.

The other side of the question is the development of the bodily resistance. This is successful in a considerable degree under the milder conditions of peace, but even if the result under war conditions is as good as this, there will remain a material incidence

of enteric fever, which will have to be dealt with in some such way as is suggested—by the elimination of the element of personal infection, whether direct or indirect.

(c) Another important point is the relation of the group of bowel complaints to the outbreaks of continued fevers. This comparison is facilitated by first of all tabulating the features of the occurrence of bowel complaints under certain heads :—

CHARACTERISTICS OF THE GROUP "BOWEL COMPLAINTS."

Ladysmith.

Duration of observations, twenty-one weeks, October 13th, 1899, to March 2nd, 1900.
Early appearance and rapid development.
Considerable similarity to febrile disease curve.
Curve characteristic : definite maxima in twelfth and twenty-first week.
Predominant type : dysentery till seventeenth week (4 to 1).
Increase of diarrhœa towards end of period ; first maximum dysentery, second diarrhœa.

Natal Field Army.

Duration of observations, fifteen weeks, November 24th, 1899, to March 2nd, 1900.
Early appearance and rapid development.
No similarity to febrile disease curve.
Sudden rise to an irregular mean incidence.
Oscillations considerable.
Predominant type dysentery (2 to 1).
Steady increase of diarrhœa during the first nine weeks, in addition to dysentery.

De Aar.

Unimportant.

Orange River.

Duration of observations, eighteen weeks, October 20th, 1899, to February 16th, 1900.
Early appearance, irregular development.
No similarity to febrile disease curve.
Characters very irregular.
Predominant type : dysentery first nine weeks, declining and replaced by diarrhœa second nine weeks.

Modder River.

Duration of observation, twelve weeks, November 24th, 1899, to February 16th, 1900.

Early appearance and rapid development.
No similarity to febrile disease curve.
Distinct early maximum and well-marked fall.
Predominant type diarrhœa.
Both dysentery and diarrhœa increasing at end of period.

Bloemfontein.

Duration of observation, twenty weeks, March 9th, 1900, to July 27th, 1900.
Oscillation about a high mean level, carried on from the Western line.
No similarity to febrile disease curve.
Predominant type: first half, diarrhœa; second half, dysentery.

Inspection shows that there are three features common to all of these groups, with an exception in the case of Ladysmith. These are:—

(1) The early appearance.

(2) The rapid development (exceptionally in Ladysmith, to a definite maximum).

(3) The absence of any resemblance to the febrile disease curve (except in Ladysmith).

In the Natal Field Army, and the force under Lord Roberts from the end of January, the features are almost identical—in both the rapid development is followed by a comparatively steady mean incidence—that is, there is no tendency for these diseases to attain more than a certain degree of prevalence, nor to a definite epidemic with a distinct decline and fall.

Ladysmith, for reasons which have already been stated in some detail, is in no way comparable with the other two main groups. The permanent occupation of a limited area, the excessive privation and the effects of the siege diet have no parallels elsewhere. These conditions possibly explain the divergent features in the outbreak there, the tendency to epidemic development (producing a maximum), and similarity to the febrile-disease curve. The garrison of Ladysmith also contained a larger proportion of men who had previously been exposed to dysenteric infection (in India) than either of the other groups, and hence the admissions in the two last probably include a greater proportion of fresh infections than in the former case.

The difference in the predominant disease cannot be taken as of very great importance; so much depends on the matter of diagnosis that the figures are probably subject to considerable errors (see p. 86).

Now these bowel complaints may be taken to include:—

(*A*) *Non-specific diarrhœas—i.e.*, those of which the cause has

not been definitely ascertained. These may then be infective or not.

(*B*) *Specific diarrhœas:* (1) dysenteric, (2) typhoid group.

The recorded admissions for bowel complaints will then include all non-specific diarrhœas, all dysenteric diarrhœas and their consequences—that is, cases diagnosed by their true name, dysentery—and probably all, or nearly all, the typhoid diarrhœas. But they do not include the consequences of infection from a typhoid diarrhœa which do not remain of the same simple type of reaction. Hence, some portion of the diseases under this head passes from observation in the group "Bowel Complaints," and reappears in the group "Continued Fevers," so that the growth of the bowel complaints is possibly slightly more of an epidemic character than the bare figures show. But apart from this, which can be but a small element, the aggregate of the non-specific diarrhœa, dysenteric diarrhœa, and dysentery showed a limitation in its development as compared with febrile disease, and tended more to a regular prevalence. The fact that the admissions to hospital represent only a proportion of the bowel complaints actually occurring does not affect this conclusion, as there is no reason to assume that this proportion varied greatly from time to time.

Within the group of bowel complaints dysentery always appeared earlier than diarrhœa—that is, dysentery appeared in the very first week of exposure—and (except at Modder River, where the conditions were unusual) its development became considerable before diarrhœa attained any prominence.

The spread of infective bowel complaints—dysentery—is conditioned by the same circumstances which spread enteric fever. The modes of propagation are, so far as we know, identical; the source is the same—infective excreta. Now a simultaneous infection of two groups of men, one with dysentery, the other with enteric fever, will, from the difference in the incubation periods, produce obvious cases of dysentery almost at once, while the obvious cases of febrile disease only appear at a later interval, and the development of the contact epidemic from each of these sources will show even greater time differences. So that the early appearance and rapid development of diseases of a dysenteric type are in this way absolutely unconnected with any development of the febrile group. The limited development of bowel complaints, and especially the comparatively early decline of dysentery (if this is, in fact, the case), is not so easy to explain; it may, however, be due to the (usually) shorter acute infective stage, and to the distinct difference in the bacterial content of the excreta, which in dysentery appear to return to the normal condition more rapidly than in enteric fever, where carriers are perhaps rarer, and where dis-

semination by the urine does not occur. Hence contact infection, both direct and indirect, is more limited in time than in enteric fever.

As to the question of a specific relation between the appearance of diarrhœa and that of enteric fever, only in one case, the Natal Field Army, do we find any similarity (and that very slight) in the time, relations, and mode of development of diarrhœa and the continued fevers (only twelve cases of *enteric fever* were recorded from this group during the period of observation). But, as has already been pointed out, the distinction between diarrhœa and dysentery cannot be accepted as a basis for close examination of relationships. It is far safer to contrast the whole group "Bowel Complaints" against the "Continued Fevers," and, having done so, we find that, as stated above, excepting in Ladysmith, no similarity existed.

(*d*) As to the sequence of events in the development of disease in the field, it has been stated that the series is: diarrhœa, non-specific continued fevers, enteric fever—pointing to a development and intensification of the infecting agent on the spot. With our present knowledge of the carriage of pathogenic bacteria by apparently healthy persons, and of the long periods after recovery from enteric fever, during which the bacillus may be carried about and excreted, it seems needless to invoke the doubtful transformation of a non-specific into a specific type to explain the appearance of this disease under conditions which apparently forbid direct infection. In passing, it may be said that, as has been pointed out in some detail already, the conditions in South Africa were by no means of this nature.

The early development of bowel complaints was apparently not related to the enteric fever outbreaks, and it is by no means necessary that such a preliminary epidemic should occur. It has been said that this preliminary epidemic occurred in some outbreaks at home, but where it has been possible to compare the distribution of the cases of diarrhœa with the dates of *occurrence* of the cases of enteric fever, not the dates of *notification*, it is found that the diarrhœa, in fact, coincided with the enteric fever and did not precede it. Further, there appears to be no reason to assume that the earlier reactions following typhoid infection are always of the type "diarrhœa"; the severity of the reaction is determined by the subject as well as the agent. This hypothetical mild reaction at the beginning would then depend either on a lessened activity of the agent or a greater resistance of the subject. There does not appear to be any evidence that the former condition is by any means invariable, and, although we know the importance of fatigue, exposure, and privation in increasing the susceptibility of the

subject, it is hardly probable that this would have any marked effect in the short period which intervenes between the onset of the bowel complaints and the appearance of enteric fever.

There is little evidence of the existence of mild non-specific fevers as the forerunner of enteric fever. No doubt mild fevers do occur—usually returned as simple continued fever—before any prevalence of enteric fever is recorded. Some small proportion of these are probably in fact non-specific, and their occurrence at this period is accidental, but the most important constituents of this group are almost certainly true cases of enteric fever which have not been diagnosed. This hesitation in the diagnosis of enteric fever at the outset of a campaign, or, in more general terms, at times or in places where enteric fever is not normally prevalent, is a familiar feature. Where and when enteric fever is expected to occur, there and then the simple continued fevers diminish in importance—that is, when enteric fever is prevalent, mild cases are recognized without hesitation which would be passed over at other times. This, and not the essential mildness of the cases, is the reason why the specific diagnosis is not made. Another factor is this: if two cases are infected simultaneously, that which is admitted to hospital the later is the more likely to conform to the usual type of disease. A case admitted on the tenth day is less likely to be passed over than one admitted on the third, and this difference of a week is somewhat important in the spacing of the epidemic. One is apt to forget that even in Europe the mild, larval, or abortive forms have been recognised for many years (Murchison), and their frequency has also been brought to notice—as by Letulle—who, in 1886, fixed the proportion as 17·4 per cent. of all cases.

One may then conclude that the early bowel complaints are not related to the development of enteric fever, that these diseases are limited in development as compared with the fevers, and that the development of epidemics of enteric fever is of the normal type, from one or more sources of specific infection, and is continuous.

(*e*) *Some Details regarding the Epidemic in Bloemfontein.*—(i) Incidence rates cannot be given. The main army arrived in Bloemfontein some 30,000 strong. The force which advanced to Kroonstadt and Pretoria from Bloemfontein and its vicinity amounted to about 42,000 of all ranks. These are the only numerical statements of strength which can be made. The first figures probably represent the greater part of the whole strength in the Free State till about the middle of April, and hence the epidemic of April 13th may be taken to be limited to this group. The last takes no account of the large aggregate of the troops at other points on the line, or scattered over the country. Now the sick in Bloemfontein were

drawn directly from the troops in Bloemfontein and the immediate neighbourhood; they were also drawn indirectly from many, if not from all, of the bodies of troops outside the Bloemfontein area, as, for example, at Glen and Vet River on the north, Edenburg and other places on the south, Sanna's Post and Thabanchu on the east, and so on. Some of the cases were sent in without coming on record at any hospital, or were, in the absence of any information, so treated — that is to say, they appear in our records as cases originating in Bloemfontein, although the strength to which they belonged was elsewhere. Where cases had come on record at some hospital outside Bloemfontein, and had been transferred there, the number who died are recorded as deaths in Bloemfontein, involving a double error, an increased proportional mortality to cases *admitted*, and an increased mortality to strength, so that it would not be possible, even if strengths were available, to ascertain with any degree of accuracy the true incidence and mortality during the epidemic. We can, however, obtain a maximum case mortality, as will be shown later. Some idea, however, can be given of the incidence during the first part of the epidemic—up to April 13th —by taking the cases in the main army from the advance into the Free State—that is, from the week ending February 16th onwards to the maximum. This will give results fairly comparable with those obtained in South Natal and the first fifteen weeks of Ladysmith, although the two latter include portions of the decline in their respective curves. These results are as follows:—

Approximate incidence per 1,000 per annum.

	Enteric	Simple continued fever	All fevers	Dysentery	All bowel complaints
Ladysmith ..	227	133	360	371	401
S. Natal ..	24	149	173	264	312
Main Army ..	167	377	544	72	216

It must again be noted that these annual rates are affected by very large errors; they are, however, necessary for comparison, and are useful if it is not pushed too far into detail.

Two things are evident—that the main army up to this period suffered less from bowel complaints and certainly from dysentery, than the other groups. Further, in the main army, the proportion of mild continued fevers was greater than in the others. Reasons have been given for believing that some part of this incidence may have been due to mild fevers not of the typhoid group, and this must be remembered in comparing these rough incidence rates. But in any case the incidence in the main army up to this time was exceptionally high.

Attention may again be called to the downward tendency of the curve from April 13th (fig. 10), notwithstanding the sudden increase on

the two occasions mentioned. This suggests an exhaustion of the susceptible population in spite of the reinforcements which arrived in Bloemfontein during the period, many of them direct from England. One may conclude from experience elsewhere—in India and South Africa—that the more susceptible of these were infected at once and went to swell the numbers ; the less susceptible escaped for the time, and formed the material for the epidemic at Kroonstadt, after its occupation, and elsewhere.

(ii) The total number of cases of all kinds admitted to hospital in Bloemfontein during the twenty weeks March 16th to July 27th was 17,141, of which 8,568 were cases of continued fever, 2,121 cases of bowel complaints—that is 50 per cent. and 12 per cent. respectively, of the total number. The average weekly number remaining in hospital was 2,629, of whom 1,054 were cases of continued fever.

The effect of the variations in the number of troops in or near Bloemfontein on the continued fever curve may be gauged by plotting out the numbers admitted to hospital for other causes than the two groups specially considered, continued fevers and bowel complaints. This shows very little correspondence with the fever curve ; the only definite resemblance is in the rise immediately after our arrival. Maxima occur on April 6th and 20th, May 4th and June 8th. There is a considerable fall from May 4th, rising again slightly to the maximum of June 8th, from which date there is a sharp fall to the 15th, a slight rise to the 29th, and then a steady fall. Thus, on the whole, the numbers admitted were steadily increasing up to May 4th, from which date they fell in two stages. Probably, then, the increase of troops in and around Bloemfontein partially determined the fever maximum of May 18th, but not the other two maxima.

(iii) *The Case Mortality of Enteric and all Continued Fevers.* —These may be regarded in two ways, first as absolute figures, and secondly, as a means of comparison of the severity (of which the case mortality is a useful index) among the four groups that are available for this purpose.

The absolute case mortality shows 961 deaths among 4,959 cases of enteric fever *admitted* to hospital—*i.e.*, 19·38 per cent.—and 964 deaths among 8,568 cases of all continued fevers *admitted* to hospital—*i.e.*, 11·25 per cent. But these relations of deaths to cases do not convey an accurate impression of the actual facts ; cases were *transferred* to the Bloemfontein hospitals without being included among the admissions, and, on the other hand, some (not many) deaths occurred among the cases transferred from Bloemfontein to other stations. These two sources of error do not balance one another. There is no question that the deaths among the

cases transferred to Bloemfontein were greater in number than among the cases sent out of Bloemfontein, first because of the larger number sent into the town in the acute stage, and secondly, because of their greater severity. Cases were sent in from the surrounding district as a matter of necessity; cases sent out were at least fit to be moved. Hence this case mortality of 19·38 per cent. is a maximum rate, and is by no means high compared with those found elsewhere.

The second use of the case mortalities is not open to the same doubt as to accuracy; each of the groups compared was under the same average conditions. We have two main groups, Colonial troops, and those for brevity called Regulars, which included some Volunteers and Imperial Yeomanry. Each of these two groups is divided into the sub-groups, officers and men. The following table shows the case mortalities in each of these groups, with the probable errors and differences, for enteric fever and for all continued fevers. The general case mortality in the corresponding groups for the whole period of the campaign is also shown in heavy type for comparison.

Comparative Case Mortalities in Bloemfontein.

	Enteric Fever			All Continued Fevers		
	Regulars	Colonials	Totals	Regulars	Colonials	Totals
Officers—						
Bfn. ..	12·58 ± 1·82	10·64 ± 3·03	12·12 ± 1·56	7·98 ± 1·19	8·62 ± 2·49	8·11 ± 1·07
S.A.W. ..	**9·73 ± 0·47**	**11·19 ± 1·30**	**9·92 ± 0·44**	**6·09 ± 0·30**	**7·35 ± 0·87**	**6·24 ± 0·28**
	2·85 1·88	0·55 3·30	2·20 1·62	1·89 1·23	1·27 2·64	1·87 1·10
	−	−	−	−	−	−
Men—						
Bfn. ..	20·37 ± 0·42	13·68 ± 1·05	19·68 ± 0·39	11·76 ± 0·25	7·86 ± 0·62	11·36 ± 0·24
S.A.W. ..	**14·28 ± 0·10**	**11·33 ± 0·25**	**13·91 ± 0·10**	**9·07 ± 0·07**	**7·46 ± 0·17**	**8·87 ± 0·06**
	6·09 0·43	2·35 1·08	5·77 0·40	2·69 0·26	0·40 0·64	2·49 0·25
	+	−	+	+	−	+

Comparative Rates between Officers and Men—Bloemfontein alone.

Officers ..	12·58 ± 1·82	10·64 ± 3·03	12·12 ± 1·56	7·98 ± 1·19	8·62 ± 2·49	8·11 ± 1·07
Men ..	20·37 ± 0·42	13·68 ± 1·05	19·68 ± 0·39	11·76 ± 0·25	7·86 ± 0·62	11·36 ± 0·24
	7·79 1·87	3·04 3·21	7·56 1·61	3·78 1·22	0·76 2·56	3·25 1·09
	+	−	+	+	−	+

The table may be summarised as follows: (1) There is really only one difference—between the Warrant and N.C.O.'s and men of the "Regulars" as here used, and the other sub-groups. The first shows a distinctly higher case mortality than the second, among whose components no significant difference exists. This distinction applies to enteric fever and to the total of all continued fevers, both

in the epidemic in Bloemfontein and in the results of the whole campaign. It may be safely accepted as a true distinction. The grouping in the case of Bloemfontein is this :—

	Enteric fever		All continued fevers	
Regular forces, excluding officers ..	20·37±0·42	.. ..	11·76±0·25	
	and			
Officers, regulars	12·58±1·82	.. ..	7·98±1·19	
„ colonials	10·64±3·03	3·69	8·62±2·49	2·83
Men, colonials	13·68±1·05	.. ..	7·86±0·62	

It may be pointed out, in relation to these comparative case mortalities, that the proportion of the total continued fevers which were diagnosed enteric fever was substantially the same in Bloemfontein and throughout the whole campaign, about 60 per cent., except in the case of the Colonial officers in Bloemfontein, where it rose to 81 per cent.

(2) Among the officers the case mortality in Bloemfontein did not show any significant variation from that obtaining over the whole campaign. Among the men of the Regulars it was higher in Bloemfontein than during the whole campaign, both for enteric fever and all continued fevers. Among the men of the Colonials, it did not differ from that of the whole campaign.

(3) The case mortality from enteric fever and from all continued fevers was then greater among the men of the Regulars than among any other group, and greater than the average of the same group over the whole campaign.

Mr. Holt Schooling, in pointing out that the death-rate from other causes than wounds was invariably higher among the men than among the officers, says that "it is probable that as a body, they (the officers) were men of better stamina than the rank and file, and perhaps were better cared for when ill" ("The Mortality Experience of the Imperial Forces in South Africa," p. 20). Here we have two propositions, which are perhaps generally accepted ; the latter, indeed, has been put more bluntly. But the fact that the case mortality among the men of the Colonials shows no significant variation from that in the two groups of officers shows that the cause must be sought elsewhere than in treatment, as at no time was there any difference in treatment between the Colonial and Regular rank and file. The Colonial troops in Bloemfontein, and indeed during the whole area of operations during the early part of the war, were men of good physique ; later on the same adjective could not be applied to the whole group.

The differences in exposure between officer and man in the advance to Bloemfontein and its early occupation can have been very small, at least for the regimental officer ; in Bloemfontein one was as likely to be attacked as the other, and it will be seen later that over the whole campaign, the officers of the Regulars and

Volunteers were attacked rather more frequently than the men of the same group.

We have then, among the group of lesser mortality, two conditions: "better stamina"—that is the result of antecedent differences in nurture, better feeding during childhood and adolescence, the habit of exercise instead of the overwork of the undeveloped youth of the labouring classes, and a habit of cleanliness in person and with regard to food, which in some degree withstood the temptation to revert to primitive savagery.

Among the Colonial troops, we have probably greater average age, the habit of life in some degree analogous to field service, and the lessened susceptibility due to previous exposure and infection. The difference in mortality then is explainable by reference to conditions which long preceded the actual attack of the disease.

CHAPTER IX.

(9) *The Later Prevalence of Enteric Fever and Dysentery.*—(*a*) From the date of our occupation of Bloemfontein, the conditions in the area of operations became more and more complicated as time went on. There were, in the first place, the lengthening lines of communication, liable to be broken at any point and consequently guarded by small bodies of troops at every station and almost at every culvert. The medical arrangements on these lines have been described in the Report on the Medical Arrangements in South Africa. There were the large garrisons of important points on and off the line : Bloemfontein, Kroonstadt, Johannesburg, Pretoria, Standerton—all permanently important as the centres from which the columns started and to which they returned for refitting. Besides these, smaller garrisons were maintained at other points of less permanent importance, such as Harrismith, Machadodorp, Potchefstroom, and other places, depending on the area in which the mass of the columns was operating. Next came the smaller garrisons of posts off the railway line, not continuously occupied and only occasionally important ; next the chains of blockhouses extending along the railway line or from point to point across country, and last of all the columns themselves, working in various parts of the area, remaining out for variable periods, but finally coming to the line somewhere to obtain supplies and refit. It is quite evident that it is absolutely impossible to examine the prevalence of these two diseases in any detail under such complicated conditions ; the sick population of a hospital was drawn from a very wide area, an area, too, which differed to some extent from week to week according to the direction from which the columns came.

On the other hand, there is little to be gained from an inquiry into the mode of propagation under these conditions. From about the date of the occupation of Bloemfontein, enteric fever and dysentery occurred in varying degrees of intensity throughout the whole area for the remainder of the campaign. It is safe to say that no known means of dissemination, except drains, oysters, and fried fish, was wanting. Numerous specific instances of sanitary mistakes or apparent neglect have been published in the medical press and else-

where, during and after the campaign, which no doubt exemplified the possible modes of dissemination which existed, but they rarely, if ever, correlated the supposed antecedent cause and the consequent case, and never revealed any new method of infection. Hence there appears to be little benefit in discussing them. Further, it is probably not unjust to say that in certain of these examples the scientific interest was not the motive which determined publication : but they all revealed one thing—the necessity of a much more complete knowledge of details than was possessed by the authors, in order to understand the true meaning of the facts as they appeared.

One has only to read the reports of the Local Government Board to recognise the very great difficulty in tracing the mechanism of infection under the comparatively simple conditions of an almost stable population and environment. How much more difficult the investigation then must be when the population is essentially mobile, the conditions varying from day to day, when also, except at once and on the spot, it is almost impossible to make any satisfactory attempt at the reconstitution of the case.

Among the various accounts of the occurrence of enteric fever and dysentery in South Africa which have been published, that by Dr. H. H. Tooth, C.M.G., of the Portland Hospital, may be specially mentioned as a careful statement of the position. Further, that portion of the Report of the Commission on Enteric Fever and Dysentery, by Colonel J. Lane Notter and Professor W. J. Simpson, contains much interesting information in this connection. This report, however, is more likely to be of use to those who have practical knowledge of the conditions met with in the field in war than to others.

(*b*) The actual conditions met with in the field, and the difficulties to be overcome, are shown in the following extracts from the Report of the Committee on Field Sanitation (assembled after the conclusion of the war), of which Colonel (now Surgeon-General) F. W. Trevor, C.B., was President, and Lieutenant-Colonels J. Meek and R. Caldwell members.

"(i) *Conditions on Trek.*—The men for the most part lived and slept in the open; no tents were provided. Shelters were made by stretching a blanket over a rope supported by a rifle or a stick at each end, over the shaft of a cart, or under a wagon. Two men generally joined in making a shelter, and sharing their blankets. Each man was allowed two, and by sleeping together, they kept each other warm and economised the blankets. There can be little doubt that this practice was responsible for the spread of disease, probably enteric, and certainly skin diseases and vermin.

"Although it was very difficult for the men to keep themselves

clean, there were very great differences in regiments as to the degree of dirt and infection with vermin. Mounted Corps, as they were more constantly on the move, were undoubtedly the worst in this respect. The Infantry and Royal Artillery, when employed guarding the railways and lines of blockhouses, had more opportunities of washing. This want of cleanliness probably contributed to the spread of enteric fever by direct contact, caused a certain amount of inefficiency from skin diseases, and aggravated veldt sores.

"(ii) *The Condition of Columns while Refitting.*—It must be admitted that the men looked upon the time spent refitting as a holiday, and possibly indulged their appetites rather freely, and this no doubt was one of the causes which led to the increased sickness noticed among the men after again starting on trek. The officers were naturally reluctant to turn their men out for fatigues (when enjoying a well-earned rest) to dig latrines and drag away dead animals and filth. The consequence was that the camping grounds round stations like Standerton or Bloemfontein, where columns were arriving almost every day, became very foul and were a source of great danger. Latterly no column was allowed to camp within a certain radius, generally three or four miles outside the station.

"Camps were occasionally pitched on the sites of old latrine trenches, and no doubt the dust and flies in such camps were responsible for much of the enteric fever."

[Note.—This applies of course to the camps of moving columns only; standing camps were on specially-selected areas. The nuisance, one may say the danger, caused by the arrival of these columns cannot be exaggerated. In addition to those points brought out in the Report, special attention may be called to the presence of large numbers of horses and transport animals and the large native establishment. At some stations, special gangs had to be employed to clean up after the departure of a column. It was quite impossible to get the irregular corps to pay any attention to sanitation.]

"(iii) *The Purification of Water in Camp and on the March.*—In standing camp, during the latter part of the campaign, all water was boiled; in hospitals and messes Berkefeld filters were also used. If boiling is properly carried out it requires a large quantity of fuel, which is a great difficulty in a treeless country like South Africa. Separate vessels must be kept (extra cooking pots were supplied, to be kept *solely* for this purpose), otherwise the water, if boiled in cooking pots, is greasy and unpalatable. There is no doubt boiling is the only method suitable to active service, but it can only be carried out when in standing camp. It is impossible to carry vessels and firewood, or to find time on the march, when the men

fill their bottles as best they can. From want of sufficient animals, water carts had to be taken empty on the march, and they were only used to supply troops when in camps. The habit of drinking water on the march is a bad one, and might with practice be controlled. It is often due to the use of strong tobacco. It was found practically impossible to prevent the men drinking foul water on the march.

"Great care was taken to select the best possible source; medical officers went on ahead of the column to select the place for filling the water carts. Sentries were posted to prevent animals and men, especially natives, fouling the supply, and a European was placed in charge of the carts to see that they were filled at the selected spot, where a pump was fixed by the Royal Engineers. A long hose was used to raise the water, and deliver in water-carts. All this was well carried out in camp, or when the columns arrived on the camping ground sufficiently early, but frequently it was after dark, and possibly pouring with rain, when the carts were probably filled at the nearest place. Then as fires and lights were not allowed if the enemy were in the vicinity, it was impossible to boil water, cook food, or dig latrines.

"Towards the end of summer, water became scarcer, and the choice of camping ground more restricted, consequently the same ground was repeatedly occupied and the surroundings became more contaminated. Diseased and exhausted animals invariably make for water, and not having strength left to extricate themselves from the mud, lie down and die, and where the banks of the spruit are steep the mortality is very great. The Modder River in particular was full of the carcases of animals. Another great cause of contamination is the natural inclination of human beings, both black and white, to seek seclusion while defæcating, and as South Africa is an open treeless country, the spruit offered the most convenient cover. The consequence was that when it rained, all the filth was washed down into the deep, stagnant pools, which contained a concentrated solution when the water ceased to flow at the end of the dry season. It was from these pools our drinking water was drawn, so it was little wonder that at this season of the year enteric fever broke out.

"The water in most South African rivers holds a very large amount of mud in suspension, so much so, that until it has been treated with alum, or some means taken to clear it, no filter is of any use, as it becomes clogged at once. In skilled hands the Berkefeld filter was very useful, but it is hardly suited to the rough usage of active service. The cylinders were always getting broken, and had to be so frequently cleaned that their efficiency probably became impaired. In hospitals and camps where the filters could

be looked after and properly treated they did good service; but in the field they were of little use. It was impossible with the means at hand to filter water for a large number of men.

"The men were encouraged as much as possible to drink tea or coffee, and some good might be done by giving an increased ration of tea, for the soldier will always drink tea if he can get it in preference to water.

"The water-carts were frequently cleaned out and disinfected. The sources of water supply in permanent camps were carefully protected, in some instances by a barbed-wire enclosure, and frequently by a guard.

"(iv) *Disposal of Excreta.*—Trenches were cut on arrival in camp under regimental arrangements, and were filled in before starting next morning, but, as before stated, this depended a good deal on what time the troops marched; if before daylight, it was often neglected. When troops halted for a few hours at mid-day no sanitary arrangements were made. Large tracts of country must have become highly infected. The Boers, of course, made no attempt whatever at sanitation, and the field hospitals were always carrying along a certain number of enteric cases, whose excreta were scattered along the line of march. It must often have happened that troops camped on the very spot where a field hospital latrine had been previously located, and in this way sudden outbreaks can be accounted for. Latterly, columns were kept as far away as possible from the towns when drawing supplies, so as to avoid further contamination of the ground, and also to get into clean ground themselves.

"Deep pits were dug alongside the kitchens, into which all refuse was thrown, and subsequently buried with chloride of lime when obtainable. Stable refuse was burnt, and also the carcases of dead animals when they were dry. The carcases were so numerous and the ground so hard that it was not generally the custom to bury them. In some instances destructors were improvised, and where plenty of stable refuse was obtainable they worked well. The sun in South Africa is, however, the best of all disinfectants, and if carcases were ripped up freely they very soon dried, became odourless, and burned well. Left exposed to sun and wind a man's excreta dries up and disappears altogether in twenty-four hours on the veldt, but not in damp, shaded spruits. The soil of South Africa is remarkably sterile in the matter of organic life.

"In connection with latrines and filth generally the question arises as to the part played by flies in spreading disease. Medical officers in the Army are unanimous in thinking that they are responsible for a great deal of the diarrhœa and enteric fever. The presence of many flies is a certain indication of a dirty camp, and

they have been traced from the latrines to the cook-house and ration stand. Quicklime freely sprinkled about is very efficacious in reducing their numbers, and in tents Keating's powder is deadly, especially when used at night.

"In connection with the removal of excreta, it must be remembered that no native establishment existed, except in large permanent camps, and everything had to be done by the men themselves. Urine was removed in cans and tubs when in camp, but at night the men doubtless micturated all over the ground.

"(v) *Zymotic Diseases.* — Enteric fever was almost the only disease of the type that calls for notice; it was the only fever seen, except in some parts, where, as at Koomati Poort, the climate was tropical and malarial fevers prevailed.

"Where large numbers of men are simultaneously attacked, the cause is probably to be found in the water; but in the columns trekking it was generally noticed that the men began to sicken a few days after leaving the town where supplies were drawn. It is now thought that enteric fever was not so frequently contracted on trek as at the depôts where thousands of men were constantly coming and going. The longer out on the veldt the healthier and better the men were.

"Where a whole regiment was using the same water-cart it can hardly be supposed that the odd cases of enteric fever could be due to water; on the other hand these can be accounted for by flies walking over the food after a visit to the latrines.

"Where large numbers of flies were destroyed in tents and subsequently trodden under foot, a horrible fœtid odour of putrescent matter was noticed. No conception of the vast number of flies can be formed by ordinary experience; it was common to see the inside of tents black with them, and so was the food, if not protected by sacking, as was recommended by the medical authorities."

The following account by Lieutenant-Colonel Coutts, R.A.M.C. (in continuation of that portion already included under the head "Modder River"), gives an idea of what happened throughout the campaign, and shows how local conditions influenced the incidence of disease:—

"To follow the fortunes of Lord Methuen's column—this marched to Kimberley about a week after the relief of that place. Enteric fever here was of the same type as that described at Modder River. The water supply at Kimberley was believed to be good, and the dry-earth system of sewage removal was carried out, but enteric fever continued as rife as before among the troops encamped on Newton Common.[1]

[1] Enteric fever was common in Kimberley before the War, and was prevalent among the civil population before the relief.—R. J. S. S.

"Lord Methuen's column, now reduced to two brigades, with a force of Imperial Yeomanry and a proportion of Royal Artillery, left Kimberley on April 2nd, 1900, and marched to Boshof, a distance of 40 miles, where it remained until May 14th. Here the two chief diseases were still enteric fever and dysentery, the latter becoming distinctly more common. Two temporary hospitals were established here; one in the schools contained eighty beds, and the other in the court-house twenty beds. A small proportion of these was set apart for wounds and dysentery, but about ninety were constantly occupied by cases of enteric fever. In addition to the sick treated locally, the field hospital records show that 363 sick were sent to the base during this period.

"The local conditions in Boshof seemed much more favourable to health than was the case at Modder River. The veldt was covered with grass, and although there was dust, it was never the trouble it was at Modder River.

"The water ran clear and sparkling from a large basin tapped by tunnels driven through a band of hard rock.

"There was a distinct falling off in the severity of the enteric fever cases consequent on the lowering of the temperature. A good deal of rain fell during the time the force was encamped at Boshof, and the nights became cold. The temperature taken on the grass registered 44° F. at 4.30 a.m. on May 1st.

"Lord Methuen's column left Boshof on May 4th and marched by Hoopstad, Bothaville, and Kroonstad to Lindley. At Hoopstad temporary hospitals were organised for about one hundred cases, of whom about twenty were believed to be enteric. At Bothaville about twenty cases, fever and dysentery, were left behind. Fifty sick were left at No. 3 General Hospital, Kroonstad, on May 30th, and the force marched for Lindley, which was reached on June 3rd. From this place a convoy of sixty sick was despatched next day, and on the 5th Lord Methuen, with the 9th Brigade, marched for Heilbron, leaving thirty-seven behind, and one brigade to hold the place. Here, by June 12th, fifty cases of enteric fever were under treatment, and it was noted that the disease was less severe in character, fewer cases presented acute toxæmic symptoms, although diarrhœa, abdominal distension, and spots were still frequent. The water supply was derived from the river, and was therefore open to suspicion, and although there were dust storms they were slight compared to those at Modder River. A convoy of ninety-nine sick and wounded was sent to Kroonstad on June 30th. From Lindley the Brigade marched on July 2nd to Bethlehem to join the force hemming in Prinsloo's commandos. At Bethlehem the sanitary conditions were no better than in the other towns passed through. The water supply was derived from the river, and was full of

suspended matter, but the typhoid season was over and it ceased to bulk largely in the hospital returns."

(10) *The Seasonal Distribution of Enteric Fever and Dysentery.*—The practical limitation of enteric fever to the season of the summer rains has been already spoken of. As this season varies somewhat throughout South Africa, the outbreaks are not simultaneous but follow one another, beginning in Natal. Hence the aggregate of cases over South Africa will show a longer period of considerable prevalence than in any single area.

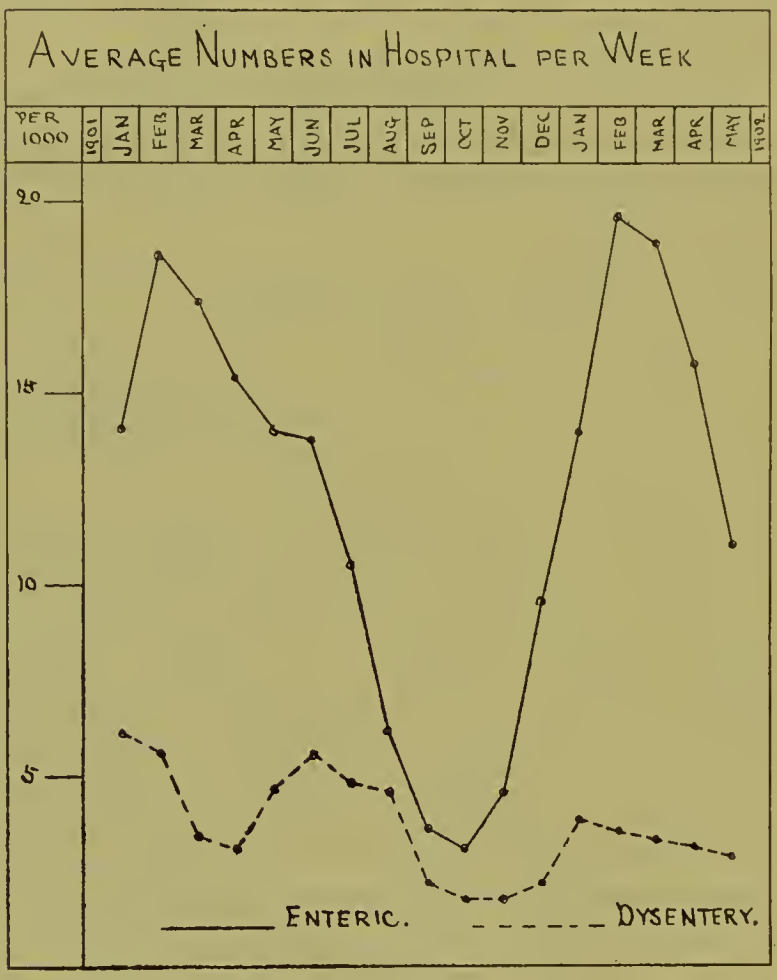

FIG. 14.

The seasonable distribution is not of sufficient importance, complicated as it has been shown to be, to justify the enormous labour of distributing the actual admissions. But records exist, compiled during the war for administrative purposes, of the number of cases remaining in hospital week by week during 1901 and 1902. From these the average number in hospital for each of the seventeen months has been calculated, and the ratio per 1,000 of the mean of the strength of the corresponding month and that preceding

has been plotted in figure 14. This gives a sufficient approximation to the relative monthly admission rates.

The maximum is seen to occur in February, the minimum in October; this last is probably artificially delayed, as compared with the *admission* minimum, by the decreasing number of admissions and the greater available accommodation in the hospitals diminishing the rate of invaliding. The maximum in 1902 was greater than that in 1901; this may be related to the greater number of troops sent from England during the summer 1901-2. Another point that has to be noted is the more rapid fall in 1902—equal ratios are nearly two months earlier in the latter year, and this rapid fall continued after the period recorded here. It was not due to any alteration in the war conditions, and though the sanitary conditions were probably rather better than in the previous year, this earlier decline suggests a limitation of the spread of disease owing to the large proportion of the force which had been immunised by previous attack. It may have been due to changes in the working of the hospitals, for at this time, owing to the wide sweeping movements, accommodation had to be reserved at a great many different points, and evacuation and invaliding were somewhat pressed.

The contrast between the enteric fever curve and that for dysentery is interesting. Dysentery, as has been already stated, shows a very much smaller prevalence than enteric fever (85·8 as against 129·9 over the whole War), and less seasonal variation. The actual number of *fresh attacks* as contrasted with *admissions* to hospital is, of course, still smaller, and the shorter average duration of the case would also reduce the numbers remaining in hospital as compared with the cases of enteric fever. It may be the case that the rise between May and June, 1901, was due to cold and exposure producing relapses as well as fresh cases. In both years the ratios fall from January to April—*i.e.*, during the warmer weather. But the figure shows on a larger scale what has already been pointed out—that dysentery tends to be limited in prevalence far more than enteric fever, and that its development is probably less determined by seasonal, climatic, conditions than that of enteric fever, possibly because of the lesser vitality of the effective agent outside of the body.

CHAPTER X.

(11) *The Mode of Propagation.*—We have seen that in four large bodies of men, an *incubation period of the epidemic* of enteric fever occurred of about eight weeks' duration—*i.e.*, more than twice the accepted maximum incubation period in the individual, and that this was independent of the environment of the troops concerned. What is the explanation of this incubation period, and in what relation does it stand to the hypotheses of the propagation of enteric fever?

Take first the hypothesis of water infection. There are two possibilities: (*a*) Specific contamination of the water supply prior to the arrival of the troops in the area supplied. This was possible in each one of these instances, most distinct in Ladysmith and Bloemfontein, possible at Modder River, and to a less degree in the Natal Field Army. (*b*) Specific infection of the water supply after the arrival of the troops by early, possibly unrecognised, cases, or by carriers among the troops. At Ladysmith this was certainly not impossible; at Modder River it was also possible, but in the Natal Field Army and in Bloemfontein at this early period, it could hardly have taken place.

It is difficult to see the mechanism in either of these two cases. In Ladysmith, and to a less extent at Modder River, one may assume pollution higher up stream, in the one case from the Boer Camps, in the other from Jacobsdal.

The difficulty in accepting an hypothesis of water infection (which applies to both cases) is the character of the outbreak, quite distinct from that sudden maturation of a large number of cases due to a general infection, so characteristic of the known examples of widespread water infection. One can only accept water infection as one of the modes by which the original cases arose in comparatively small numbers.

Take, again, the question of soil infection, in which, as in water, there are two divisions, before and after the arrival of the troops. Both hypotheses assume the existence of antecedent cases, but soil infection would appear to demand a greater prevalence than water. In Ladysmith, all conditions were favourable to a widespread soil infection, which probably did in fact exist. In the

Natal Field Army it cannot be assumed ; at Modder River before our arrival it probably did not exist, but after December it must have existed to a considerable extent. In Bloemfontein it probably existed. So that we do not find an equality of conditions among the four groups, and the one hypothesis will not apply to them all. Soil infection must act more slowly than water ; it acts indirectly through infection of the water supplies, or directly through dust infection of the food, or even possibly by inhalation. Both of these modes of action are determined by non-continuous factors, rainfall and wind. However important soil infection may be in maintaining an epidemic which has originated otherwise, it is difficult to conceive it as the agent transforming a small prevalence into a sudden epidemic.

During the South African War there were innumerable foci of infection, each of which probably gave rise to a greater or smaller number of cases dependent on the radius of action of each of these foci. Now if we are to assume that the outbreaks we have been considering were due to infection from without, we must assume (from the maturation of the greatest number of cases within a limited period) that the foci of origin were either of extensive radius (such as a water or possibly a soil infection), or while individually small, were very numerous, *and all specifically active about the same time but only over a period which must have been short.* It appears on the one hand that neither water nor soil infection will explain the mode of development of the epidemics, and on the other, that though innumerable foci were present and active, their activity is not known to have been especially greater at one and the same time, or limited in duration. So that none of these external causes suffice to explain the mode of development of these outbreaks.

There remains the theory of personal contact, using this term, as before, to include direct personal infection from close association, the infection of a commensal, and indirect infection through excreta. If this remains unchecked, the development must increase till all susceptible individuals within range are infected. The original case is capable of infecting a small number of individuals who are in close association with him, each of these cases can in turn infect a further number of individuals, and so the number of agents is constantly increasing. Where the group in association, through common life, common latrines and the like, is small, the result is the so-called "company" outbreak. Now under ordinary peace conditions, there is probably no better means of spreading an infective disease than the life in common, such as the soldier lives, especially where the system for the removal of excreta wants the certainty of a water-carriage system. One has daily examples of this in the countries in which enteric fever is endemic—India and

South Africa. On service, all the evil features of the life in common are aggravated: blankets, clothes, and the like become more or less common property, personal cleanliness is but a thing to hope for, the mode of disposal of excreta at its best is imperfect, as a rule it is haphazard; much more discipline in this matter is wanted. The detection of typical attacks in the early stage, still more the recognition of the atypical forms of infection, is extremely difficult; the men do not report sick early; if they do, it is almost impossible (even if it were desirable) to retain them under observation in the first line hospitals, and what is still more important, to take steps that such presumably infective cases shall remain harmless. Hence the range is only limited by the number of susceptible individuals in the force. This appears to have been the cause of the extraordinary prevalence in Ladysmith, while in Bloemfontein the range appears to have been unlimited, as the number of susceptible individuals exposed was continually receiving reinforcements from England.

Now the curves of development in these four groups certainly suggest a growth of this type—an auto-infection—while they do not appear to be explained by any theory of external infection of the mass.

The sequence of events, in the development and propagation of enteric fever and dysentery, appears to have been the infection of a certain number of cases from an external source and the growth of the infection from individual to individual throughout the group. The lesser prevalence of enteric fever and dysentery in the later stages of the war was partly due to the smaller size of the groups.

(12) *The Influence of Reinforcements on Prevalence.*—In a campaign of any duration the proportion of reinforcements will always be considerable. Reference to the tables in App. A and B will show the numbers sent out to South Africa at various periods.

The question of the relative susceptibility of men from various sources was raised at an earlier period. It has been shown (Army Medical Department Report, 1898, p. 502) that in Natal the admission-rate for enteric fever in 4,232 men from England was 39·3 per 1,000, in 3,223 men from the Cape, 33·2, and in 3,048 men from India, 23·6 per 1,000—that is, the prevalence in Natal was inversely as the previous exposure to infection. But this protection of troops from India as compared with others has been seen to break down in the case of Ladysmith, where the majority of the men were "salted" by previous exposure. Similarly it has been shown that in India, at times of exceptional prevalence, the older men of longer service suffer, and diverge from the mean as much, if not more, than the younger men (Army Medical Department Report, 1906, p. 38). Against this, we have the greater liability of

the younger, newly-arrived soldier to attack. In India between 1897 and 1906, 62 per cent. of the cases were in men under two years service, 75 per cent. in men under three; in Natal (1893-7) 61 per cent. in the first year, 19 per cent. in the second, or 80 per cent. within the first two years after arrival (Army Medical Department Report, 1906). Each of these statements really means, if the time of the trooping season be kept in mind, that given an endemic prevalence, the new arrival is usually attacked on the first opportunity.

Hence we had in South Africa two elements tending to increase the prevalence, the failure of the normal protection of the men of longer service under the stress of the campaign, and the constant inflow of men without any degree of natural protection. Inoculation, imperfect as the method then was, appears to have had some influence for good, both on prevalence and mortality.

These two elements, failure of protection among the men of longer service and the immediate susceptibility of the new arrival, are probably always effective in war, but the latter was exceptionally active in South Africa on account of the very high proportion of reinforcements.

(13) *Modes of Prevention.*—Of the two modes of propagation of enteric fever and dysentery, infection from without is mainly limited to water infection, direct through drinking water or aerated waters, and other prepared drinks. There seems to be no reason why with proper methods of filtration, or of sterilisation (which seem now attainable), and with a specific organisation for the supply of pure water (which now exists), the risks of infection from this source should not be rendered almost entirely negligible, provided that the scheme is supported by the individual action of every man of the force, or by the somewhat unfortunate and far less effective alternative, strict discipline. How far the possibilities of the scheme, which appear to be unlimited, will be realised in practice remains for the test of war to decide. It is, on the whole, more likely to be effective where recognised tactical units of the regular forces are concerned than in the equivalents of the "columns" of the South African War, especially where irregular troops are employed.

There is also the possibility of infection from without through the occupation of infected towns, villages, or camps. If the necessity of guarding the force against infectious disease be recognised to be as important as that of guarding it against the other hazards of war, it should be possible to avoid this, except under unusual conditions. History shows that too great avoidance of possible risk from the enemy has not been infrequent, while, on the other hand, too little regard has been paid to the risk of infectious disease. It

must, however, be remembered that in such a country as South Africa, routes and stages were usually determined by the river system—on the one hand for the sake of fords, on the other for the only available water supply—and under such circumstances, one force following another must often make use of sites that have already been camped on. There is, however, no doubt that great laxity, often inexcusable, existed in the marking of latrine trenches and rubbish pits.

Without attempting in any way to lessen the importance of the supply of pure water, there is, without doubt, increasing strength of opinion that the provision of pure water is only one, and possibly not the most important, element in prevention. One may, for example, contrast the practical disappearance of cholera from the British garrison of India with the continued prevalence of enteric fever. The provision and distribution of pure water is probably practicable if it receives the attention it deserves; the avoidance of infected areas should normally present no difficulties. But when we come to the prevention of infection from within—contact infection—the serious difficulties begin. These difficulties fall into two groups: first of all, it is difficult to secure your case at the earliest moment; next, having secured and recognised your case, comes the problem of how to deal with those who have been in contact with him. Take the easiest case of all, that of a unit, say a battalion, forming part of a brigade when things have settled down after the first confusion of the disembarkation, which is just about the time one would begin to look for the very earliest cases of enteric fever. Suppose one man of that battalion is infected from without. He forms one of a group of men who are associated in every possible action of their daily life. After malaise, lasting, perhaps, a week, and possibly some diarrhœa, he reports sick to the medical officer of the battalion, by whom he is sent to the field ambulance, thence to the clearing hospital, and so to a stationary hospital on the Lines of Communication, where he suffers from, say, a normal attack of enteric fever. The medical officer of the battalion can hardly form a diagnosis that is of any value, he may note the case as suspicious. In the field ambulance little more can be done, cases cannot be retained there for observation, and so it is not until the patient has reached the stationary hospital that sufficient certainty of diagnosis can be attained to justify the measures which, irksome under peace conditions, become almost impracticable in the field—*i.e.*, thorough disinfection and isolation of the contacts.

Meanwhile, what has happened to the brigade? It has gone on; possibly fought an action in which the battalion lost heavily. Probably the group to which the patient belonged has been broken up and the individuals cannot be got together again, certainly the

blankets and kit which were left behind when the patient went sick have been used by his associates. The result is that in many cases it is not possible to have any control over the men of the group, some of whom are probably infected, and like the first case are spreading infection broadcast. What can be done in such a case? Nowadays, with the case in barracks, we should all deal with it on the most stringent lines, evacuation of the room, disinfection of everything that can be disinfected, and quarantine of the men who were in the room. Suppose the simplest case, where the group has remained recognisable and available; disinfection of their kit is probably possible in some way or other provided there is time. But what is to be done with the contacts? Complete isolation short of sending them to hospital or special camp is not practicable.

The following measures are suggested for consideration:—

(*a*) A stringent adherence to the regulation that every man shall take the whole of his kit with him when he reports sick. For this the company officer should be held responsible. In all suspicious cases the whole of the kit should be disinfected, and it would be wiser where possible to deal with the kits of the contacts also.

This question of kit is rather complicated. Probably we shall not see again those enormous kits which many men possessed in the early days of the South African War (when the distribution of "gifts" was ill-regulated), which were a source of serious embarrassment to the hospitals. On the other hand, the normal service kit is small; after a little wear and tear, the man has probably only one set of clothing which is at all fit for use. Hence if his kit is to be disinfected, he must be accommodated somewhere while the operation is going on. Also, for the same reason, the method of disinfection which is adopted must be one which damages the articles as little as possible; this appears to exclude certain rough and ready methods which are otherwise practicable if time allows. One cannot well boil garments if they are to be rendered too small for use. Time and the difficulty of replacing articles are the two obstacles in the way of extensive disinfection in the field. It appears, however, to be quite practicable to design a satisfactory method which can be carried out in the field ambulance.

(*b*) The provision of special latrines for that company in which the case occurred, these latrines to be specially looked after by the battalion sanitary detachment. The contacts at least to report to the N.C.O. of the detachment after using the latrine so that their excreta may be rendered harmless at once. A special issue of disinfectants for this purpose, and transport for it will be necessary. It is better not to trust to any general scheme for the disinfection of the latrines.

(*c*) A careful medical inspection of the company, and especially

of the contacts. As regards the latter, their temperatures should be taken (best in the evening, if possible, and remembering the effects of exertion); a record of stools should be provided by the N.C.O. of the sanitary detachment. Any man who appears out of sorts should be put on the "contact" list. It is, of course, probable that such an inspection could not be carried out daily without a break, but there seems no reason why under ordinary conditions of war, an inspection which is of practical use should not be possible.

We have to be careful that our sanitary control shall not trespass upon what is after all the primary object of war—successful movement against the enemy, and up to a certain point, the risk of epidemic disease must be accepted as one of the ordinary risks of war. What we have to do is to reduce this unavoidable risk to the lowest possible. Wastage of the fighting line is, even apart from epidemic disease, always a source of anxiety, and under any circumstances, when a man is sent back from the fighting line it means the loss of his services for considerably more than the period which is covered by his disability. Hence it is not possible that any scheme, involving the loss of men from the fighting line, could be accepted unless it can be shown that such a removal is in the end beneficial—that is, that it maintains the fighting strength at a higher level than any other method.

That is our difficulty with regard to enteric fever; the infectivity so long precedes the obvious disease,[1] the early diagnosis is so obscure, that infection has in all probability taken place before any one is aware of the existence of the infecting agent. If we can show that the immediate removal of the contacts, at least five men for every case, instead of temporising in the way suggested above, will cut short an outbreak, then it simply becomes a matter of proportional loss from the fighting line. But a short calculation will show that the loss so caused exceeds that resulting from a severe epidemic.

We have been given a sanitary organisation which should, with the concurrence of the individuals of the Army, enable us to maintain complete control over possible infection from recognised cases, *i.e.*, after their recognition. We must, it seems, develop a similarly complete scheme for the early recognition of suspicious cases. This involves two things, a more complete supervision of the men of the force who do not report sick, a matter which does not present insuperable difficulties, and greater care in

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[1] Simon in six cases found bacilli in the stools from one to twenty-five days. Conradi, eight to eleven days before the earliest symptoms.—*Klinisch. Jahrbuch*, xvii.

relation to those doubtful cases of indefinite pyrexia, permitting none of them to be disguised under the term "pyrexia of uncertain origin," unless and until the most careful examination has failed to account for the condition. In the stationary hospitals, at least, the old rule should be followed in regard to prevention, which has been followed for many years in treatment—to consider every febrile case which remains unexplainable as one of enteric fever. It would probably pay in the end if every febrile case, however mild, however reluctant to go, were sent from the first line hospitals at once to those on the line where disinfection and sterilisation, as well as diagnosis, can be adequately carried out. In this way, though the loss to the fighting line might for the moment be greater than was absolutely necessary, we should certainly cut short the period during which the really infective case was spreading infection in the field, and so diminish the total loss. If it were possible in the field to distinguish the typhoid diarrhœas from those due to unimportant causes, they too should be treated in this way. Contact infection is at least as important as water infection, and in one way more so, in that it demands the prior existence of an infective case which is, or should be, under our control. It is this control which is the vital point; in systems of water protection we are insuring against a possible risk, in the elimination of early or atypical cases, we are ensuring the removal of a certain source of infection. The removal of acute cases of dysentery from the front is hardly less necessary, though here the question of contacts is less important, as the declared disease follows infection more rapidly.

The question of carriers is important. Although the proportion is small, yet the danger has been demonstrated repeatedly. As regards the Army, prior to mobilisation, every man who has had enteric should be retained under observation until it has shown whether or not he is a carrier, permanent or intermittent. The permanent carriers, irresponsive to treatment, are no longer fit for service. Where the danger lies is in the recruits, reserve men, possibly attacked in the interval of their service, and in the civilians, natives and others, employed in subsidiary branches, especially the transport. It is possible to deal with recruits on enlistment, and perhaps with mobilised reservists, though this seems difficult, unless it was arranged to accept a certificate of attack as rendering the man temporarily unfit until proved to be free from infection. As regards civilians employed, the matter is hopeless; it is the one avenue which we cannot close, usually we cannot pick and choose when we require their services.

We may by inoculation help our efforts against the entrance of infection by diminishing its activity after it has entered the body.

This will probably not eliminate all possibility of infection, though it lessens the frequency and severity. But the detection and elimination of carriers, and inoculation, have no place in the field, they must be carried out without undue pressure before the troops embark.

(14) *The Result of an Admission for Continued Fever.*—Of the 57,684 cases of enteric fever admitted to hospital, according to our records,

(*a*) 8,022 or 13·9 per cent. died.

(*b*) 19,454 or 33·7 per cent. were invalided.

(*c*) 30,208 or 52·4 per cent. were discharged otherwise—*i.e.*, (1) returned to duty, or (2) some other disease supervened, or (3) remained in hospital at end of record.

Of the 33,033 cases of simple continued fever, 30,879 or 93·5 per cent. were discharged otherwise as shown above.

In a large proportion of the cases originally admitted as simple continued fever, the disease was changed to enteric fever later on, and in compiling the consolidated returns, such cases have been eliminated and shown only under the heading of enteric fever.

The important item under both headings is the number returned to duty; the cases in which the disease was changed or which remained in hospital at the close of record are comparatively few.

We have, then, something like 30,000 men returned to duty after having suffered from enteric fever, and, according to recent work, among that number there were probably 3 to 4 per cent. who were carriers, say about 1,000 men. To these must be added the carriers among the large proportion of the invalids who returned to South Africa and rejoined the fighting line, and, further, a proportion of the cases of simple continued fever returned to duty, which together might add another 600 to the 1,000 carriers mentioned above.

These form an important number of infective foci. It is not possible to trace their influence on the general prevalence during the War. This total was, of course, not thrown into the force at a definite time, but increased *pari passu* with the development of the general prevalence. But it raises the very serious question of the disposal of cases of enteric fever on Service after their recovery.

The total corrected admission-rate for enteric fever among the Warrant and N.C.O.'s and men of the whole force was 129·9 per 1,000 of strength. Converting the percentages shown above into ratios per 1,000 we have:—

Died	18·06	129·90
Invalided	43·78	
Discharged otherwise	68·06	

Allowing 8 per 1,000 for change of disease and remaining at the close of record, we have somewhere about 60 per 1,000, of whom

some 3 to 4 per cent. are carriers, *i.e.*, something between 2 and 3 per 1,000 of strength.

The invaliding of every man who had suffered from enteric fever, to the zone of the home territory, would solve the problem from the sanitary side; it would admit of the elimination of the permanent carriers, and of the comparatively early return to the fighting line of those who were entirely free from infection, and later of those who were curable. But the loss caused by this "roast-pig" method is outside the possible limits. The loss to the fighting line in South Africa from death (permanent) and invaliding (temporary) was over 60 per 1,000. We cannot afford this enormous increase in the temporary loss for the sake of insuring the elimination of the relatively small number of cases infective after recovery.

What other possibilities remain? It is quite certain that the bacteriological investigation of recovered cases of enteric fever cannot be carried out in the zone of the field army, where, however, these cases should not be until they are shown to be harmless. It does not seem impossible, on the other hand, to carry out such an examination on the Lines of Communication, where there are large hospital establishments, and laboratories which should be adequate for these investigations. It would probably not be impossible to arrange for quarantine stations for the segregation of those enteric cases who are fit to return to duty, provided they are non-infective. The whole establishment of these stations (except the medical officers and a small permanent staff, to be responsible for the equipment and the like) would be provided from the officers and men in quarantine.

In South Africa the average number of days under treatment of a case of enteric fever was fifty-six. The average time required for the examination as to infectivity is hardly determinable so far if it is decided to exclude the intermittent carriers, which is, of course, desirable, but probably not practicable. Taking as a practical minimum the elimination of those found infective after not more than two examinations, the total absence from the ranks would amount to about ten weeks—that is, quarantine for examination practically increases the temporary loss by 25 per cent.

The material advantage of following such a course has to be considered. Unless we are prepared and able to maintain other conditions at their very best—unless we can exclude the other and more frequent sources of infection, especially those arising from early cases and those still in the stage of incubation—it seems hardly possible to put forward the necessity for this elimination of carriers. Certainly under the conditions in South Africa it is difficult to see that the gain would in any way have counterbalanced the additional loss of men in the fighting line. There is a limit to

the possibilities in *personnel*, equipment, and transport, and to the demands of the medical service on other branches of the Army—demands which at times conflict with the other duties of these various branches, and this being the case it appears wiser, for the present at least, to concentrate our efforts on the prevention of infection by the more usual methods, and especially on the detection of early cases. So far as we are successful in this, so far will the importance of this particular problem diminish automatically. One direction in which additional effort would probably be of great advantage is in the medical inspection and care of civilian and native followers.

CHAPTER XI.

(15) *Comparative Prevalence and Mortality by Groups.* — (*a*) The army in South Africa was composed of two bodies of men whose disease history differed very much—the Colonial troops and the rest. As regards the former, we may assume without serious error that no very marked difference existed between the different components of the whole group in their previous exposure to epidemic disease. The remainder, on the other hand, consisted of two groups, the Regulars and Volunteers, and the Imperial Yeomanry, of whom the latter had been less exposed than the the former. Among the Regulars and Volunteers, the number of men from India (with a higher degree of protection) was about the same as the number of Volunteers from England (with a very low degree of protection), so that the average condition in the whole group was not seriously disturbed by the inclusion of these two groups, varying in themselves from the average. A large proportion of the reinforcements had very little protection previous to their arrival, but as the War progressed an increasing proportion were protected by attack in South Africa, so that the group as a whole had some degree of protection. In the Imperial Yeomanry, on the other hand, there was for nearly the whole of the force no previous exposure, nor (from the relief of one contingent by another) the same tendency to increase of protection as the War went on; that is, experience would lead one to believe that, on the whole, Colonial troops were less likely to suffer from a high incidence of enteric fever, but on the other hand were more likely to be affected with some degree of chronic dysenteric infection, and that the Imperial Yeomanry were more likely to suffer from a high incidence of enteric fever and less likely to show any antecedent dysenteric infection than the Regulars and Volunteers.

(*b*) In each of these groups we have the two classes—officers and men. The characteristics mentioned above apply more especially to the rank and file; the relations of the officers of the different groups vary somewhat from these.

At the beginning of the War the officers of the Regulars showed the normal age distribution—*i.e.*, a preponderance of the younger men of shorter service. Owing to the shortage of officers this

preponderance became more marked as time went on and the vacancies were filled up by very young officers, many of whom joined their units in South Africa, direct from the military colleges or the Militia. Their degree of protection cannot have differed materially from that of the men of the drafts. The officers of the Imperial Yeomanry, on their first arrival in South Africa, included a comparatively large number of those who had already served in the regular forces or elsewhere abroad, and though the proportion of young officers was considerable (probably not as great as in the Regulars and Volunteers), vacancies in the later contingents were filled up to a considerable extent by promotion of those who had served in the ranks in South Africa in an earlier contingent and had been exposed to infection. They were probably better protected than their men. The officers of the Colonial troops again were still more likely to be protected by previous infection, probably at least as much as their men.

These are the rough outlines of the probable conditions as regards previous exposure, attack, and protection in the various groups. (The effect of the limited inoculation that was carried out has been neglected entirely at this point.) It is interesting to see how far these are reflected in the tables of incidence, mortality, and case mortality for the epidemic diseases for the several groups.

(*c*) It has been shown (p. 50) that a correction of the total *recorded* admissions and deaths was necessary owing to the fact that our recorded deaths for disease among the men showed a loss of 18·98 per cent. In preparing the more detailed tables which follow, relating to the various groups, similar corrections have been made; the loss, however, is not the same in each of the groups, but as shown below:—

		per cent.		per cent.		per cent.
Officers ..	Regs. and Vols.,	14·1 ..	Imp. Yeo.,	16·6 ..	Colonials,	15·6
Men ..	,, ,, ,,	18·7 ..	,, ,,	19·4 ..	,,	20·8

The numbers recorded have been corrected in these proportions and used to calculate the incidence and mortality per 1,000 of strength, but the case mortality has been calculated from the recorded admissions and deaths, and has, therefore, a higher degree of accuracy.

(*d*) It appears to be possible to answer the following questions from a consideration of the ratios given in these tables (App. E and F), within the limits of error of the figures:—

(i) Is there evidence of the protective effect of previous exposure and attack *even under war conditions?*

(ii) Is the incidence, mortality, and case mortality the same among officers and men?

(iii) Are enteric fever and dysentery alike in these relations?

For easier comparison the detailed numerical results may be summarised as shown below. Where there is no significant difference a blank is shown. Instead of inserting the actual numerical ratios, the proportion of the rate among officers to that among the men, and similarly in the other groups compared, is given in order to facilitate comparison, but it must be distinctly understood first that the individual differences are frequently very small, though the ratio of the two is large, and secondly, that these ratios are subjected to errors, often comparatively large. These errors are, however, given in the larger tables, and may be referred to in case of doubt :—

COMPARISON OF RESULTS.

	Incidence		Mortality		Case Mortality	
Enteric alone—						
Officers R. & V.	106	Men 100	Officers 70	Men 100	Officers 66	Men 100
I. Y.	63	100	57	100	—	—
R.V.&I.Y.	—	—	70	100	68	100
Colonials	78	100	75	100	—	—
Total	95	100	68	100	71	100
All Continued Fevers—						
Officers R. & V.	105	100				
I. Y.	72	100				
R.V.&I.Y.	—	—				
Colonials	78	100				
Total	97	100	As above		As above	

Regulars and Volunteers — Imperial Yeomanry.

Enteric alone—						
Officers R. & V.	118	I. Y. 100	R. & V. —	I. Y. —	R. & V. —	I. Y. —
Men	70	100	74	100	—	—
All Continued Fevers—						
Officers R. & V.	115	I. Y. 100				
Men	79	100	As above		As above	

Regulars, Volunteers, and Imperial Yeomanry. — Colonials.

Enteric alone—						
Officers R. V. & I. Y.	198	Col. 100	R. V. & I. Y. 176	Col. 100	R. V. & I. Y. —	Col. —
Men	153	100	190	100	126	100
All Continued Fevers—						
Officers R. V. & I. Y.	208	Col. 100	As above		As above	
Men	160	100	,,		,,	

Taking the three questions in order :—

(i) There appears to be undoubted evidence of the protective effect of previous exposure and attack, even under war conditions.

(*a*) The officers and men of the Regulars, Volunteers, and Imperial Yeomanry taken together show a much higher incidence and mortality, and the men a higher case mortality than the corresponding classes of Colonial troops.

(*b*) The officers of Regulars and Volunteers show a higher incidence rate than the officers of Imperial Yeomanry. The men

of Regulars and Volunteers show a lesser incidence and mortality than the men of Imperial Yeomanry.

(c) The officers of Regulars and Volunteers show a higher incidence rate than the men of the same group. The difference is not great but is quite distinct.

These results also hold good if the total of the continued fevers be used instead of enteric fever alone.

(ii) The officers of the Regulars, Volunteers, and Imperial Yeomanry taken together show an equal incidence and lesser mortality, and a smaller case mortality than the men. (The only exception under this head is the greater incidence among officers of Regulars and Volunteers than among the men.) The Colonial troops follow the same rule, but the difference is less marked than in the Regulars, Volunteers, and Imperial Yeomanry, and the case mortality is indistinguishable between officers and men.

Possible reasons for this distinction have already been considered in relation to the comparative results in Bloemfontein. If we take the mortality rates in order of magnitude, as below, some additional light is thrown on the subject:—

Mortality Series, Enteric Fever.

Men	Imperial Yeomanry ..	26·07 per 1,000	
	Regs. and Vols. ..	19·37	These do not differ significantly;
Officers	Imperial Yeomanry ..	14·75	the differences between the other
	Regs. and Vols. ..	13·59	pairs are all significant.
Men	Colonials	10·36	
Officers	Colonials	7·81	

Now men of the Colonial troops showed a lesser mortality than any other group except their own officers (about half that in the Regulars and Volunteers), and again, as far as the figures go, the officers of the Imperial Yeomanry showed a mortality which is not distinguishable from that of the men of the Regulars and Volunteers. The conclusion seems to be that the sum of the various conditions which, taken together, we call "stamina" is the important element.

(iii) The similarity of enteric fever and dysentery in these relations.

The following table summarises the results as regards dysentery:—

	Incidence		Mortality		Case mortality	
Dysentery alone—						
Officers R. & V.	—	Men —	Officers ? 72	Men 100	Officers —	Men —
I. Y.	—	—	—	—	—	—
R. V. & I. Y.	—	—	? 73	100	—	—
Colonials	65	100	—	—	—	—
Total	89	100	? 71	100	—	—

	Incidence		Mortality		Case mortality	
All bowel complaints—						
Officers R. & V.	115	Men 100	Officers ? 73	Men 100	Officers 65	Men 100
I. Y.	—	—	—	—	—	—
R. V. & I. Y.	113	100	? 73	100	66	100
Colonials	68	100	—	—	—	—
Total	? 104	100	? 71	100	69	100

(There was an unusual proportion of diarrhœa cases among the officers, R. & V.)

Regulars and Volunteers. — Imperial Yeomanry.

Dysentery alone—						
Officers R. & V.	—	I. Y. —	R. & V. —	I. Y. —	R. & V. —	I. Y. —
Men	88	100	—	—	—	—
All bowel complaints—						
Officers R. & V.	—	I. Y. —	R. & V. —	I. Y. —	R. & V. —	I. Y. —
Men	88	100	—	—	—	—

Regulars and Volunteers and Imperial Yeomanry. — Colonials.

Dysentery alone—						
Officers R. V. & I. Y.	264	Col. 100	R. V. & I. Y. —	Col. —	R. V. & I. Y. —	Col. —
Men	180	100	182	100	—	—
All bowel complaints—						
Officers R. V. & I. Y.	188	Col. 100	R. V. & I. Y. —	Col. —	R. V. & I. Y. —	Col. —
Men	173	100	181	100	—	—

From this we can see that the results vary in the same direction as those for enteric fever. This shows that there is no evidence of general antecedent infection among the groups previously exposed. The differences, however, chiefly affect the incidence rates, which are less reliable than the mortalities, as they are so much influenced by habit, as seen in the greater proportion of admissions for diarrhœa among the officers of the Regulars and Volunteers. The men of the Regulars and Volunteers showed a smaller incidence than those of the Imperial Yeomanry, both in dysentery and all bowel complaints, the mortality and case mortality are identical within the limits of error. The officers and men of the Regulars, Volunteers, and Imperial Yeomanry showed a higher incidence rate, and the men a higher mortality than the same classes of the Colonial troops; the case mortalities are identical within the limits of error. Among the Regulars, Volunteers, and Imperial Yeomanry the incidence rate was the same in officers within the limits of error. Colonial officers showed a smaller incidence but the same mortality as their men. The case mortality of officers and men in each group was indistinguishable within the limits of error, though not for all bowel complaints, where it was less among the officers.

The mortality rates for dysentery, arranged in order of magnitude, are as follows (the sequence is the same as in the case of enteric fever):—

Men	Imperial Yeomanry	3·62 per 1,000
	Regs. and Vols.	3·28 ,,
Officers	Imperial Yeomanry	2·69 ,,
	Regs. and Vols.	2·38 ,,
Men	Colonials	1·81 ,,
Officers	Colonials	1·34 ,,

Instead of showing an interrupted series as in enteric fever, these rates show no distinctive differences between any two consecutive values if the limits of error are considered.

If, then, the smaller non-significant variations are eliminated, we find here fewer and smaller differences in the incidence, mortality, and case mortality of the various groups than in the case of enteric fever. "Stamina" appears to have been of much less importance, though not negligible, probably because acute dysentery (at least in South Africa) is, on the whole, as regards its immediate severity, a much less serious disease than enteric fever, and its shorter duration does not involve so prolonged a demand on reserves of strength. One cannot, of course, compare the case mortalities in the two diseases; the enteric fever ratios are almost entirely concerned with fresh infections, those for dysentery include both fresh infections and relapse cases, so that in dysentery the actual proportion of deaths to infections is higher than is shown in these tables. This, however, must always be the case, except where special care is taken to differentiate the admissions into the two groups. There is no evidence of the effect of previous infection producing a higher incidence rate in those previously exposed; this, however, may be obscured by the preponderance of fresh infections. There is, on the other hand, a tendency to the same type of distribution as in enteric fever, a smaller incidence and mortality among the seasoned men.

The question naturally arises whether any other differences existed among these groups beyond those already mentioned. The Colonial troops, especially the over-sea Colonials, as a whole, were inclined to drink tea rather than raw water. But in the other troops this habit became established after the earlier period, where and when it was possible to boil water, and these possibilities were the same for both groups. Further, the compulsory boiling of water was carried out when practicable, and probably more by the regular troops than by any other group. So that this difference in habit was probably of less importance than at first appears. On the other hand, the Regulars and Volunteers were the only troops who made any systematic attempt at satisfactory sanitary arrangements. The Colonial troops were careless in this respect, and the Irregular Corps absolutely impossible. It is, of course, the case that this neglect may have affected other bodies than those actually at fault, but this applies only in the field; in camp the sinners too would be exposed to a greater risk of infection. It does not appear that the differences in environment are by any means sufficient to explain the differences in the results as shown above.

As regards the greater incidence of enteric fever among the

officers of the Regulars and Volunteers than among the men, a comparison with the Indian records is interesting. (See Army Medical Department report, 1908, p. 104.) Taking the years 1898-1908 (both inclusive) for India, the results are shown below :—

Incidence.	*Officers.*	India	.. *143*	South Africa	.. *106*
	Men.	,,	.. 100	,,	.. 100
Mortality.	*Officers.*	,,	.. *100*	,,	.. *70*
	Men.	,,	.. 100	,,	.. 100
Case mortality.	*Officers.*	,,	.. *72*	,,	.. *66*
	Men.	,,	.. 100	,,	.. 100

That is, the incidence among the officers was distinctly higher in India relatively to that among the men than in South Africa ; the mortality was also higher, but the case mortality was about the same.

The South African rate among the officers was about 5·5 times the Indian rate ; among the men it was about 7·6 times the Indian rate. There are certain obvious and well-marked differences in the environment of the officer in India as compared with the man ; these differences were in South Africa largely negligible. It is not probable that the age composition of the group officers was more favourable than in India ; indeed, the opposite is probably the case. Both groups, officers and men, were exposed to a maximum infection in South Africa, but one group showed a definitely greater increase than the other if the Indian rates are taken as a standard, There seems to be only two possible explanations of this difference—either the officer was relatively more careful in South Africa than in India, or there is some element in the environment in India which is less favourable to the officer than any of the conditions affecting the life of the men.

There was one considerable difference in the relation of the officer to the man in South Africa as compared with India, and that was in the matter of food. In India both classes probably make use of an excessively nitrogenous diet, and for a part of the time the same thing occurred in South Africa. But taking the War as a whole, the food of the officer resembled that of the man far more than it does in India, both as regards quantity and composition. This difference is suggestive in view of the hypothesis that has been advanced from time to time that an excessive meat diet, with intestinal putrefaction as a sequel, increases the liability to attack. It is in any case clear that the difference is not one of diagnosis—that is, that the incidence rate in India is not artificially raised by the inclusion of mild cases which are omitted among the men, for the mortality per 1,000 among the group officers in India is not only the same as among the men, but shows a similar variation from year to year.

The results shown in these tables may be summarised as follows :—

(*a*) As regards enteric fever, the experience of previous years is found to apply during war as well as in peace—that is, such troops as have been exposed to infection, and of whom a certain number have been attacked and survived, show a degree of protection as compared with others who have not been similarly exposed. This protection is, however, likely to break down under extreme conditions.

(*b*) Officers continue to show a higher incidence rate but a smaller case mortality than the men.

(*c*) Though less well marked, the distribution of dysentery among the various groups tends to resemble that of enteric fever.

(16) *Comparative Incidence and Mortality per* 1,000 *by Arms of the Service and by Corps.*—In using these tables, three things must be remembered :—

(i) That the incidence and mortality rates are not *annual* rates, and are therefore not comparable with the rates given elsewhere ; they are calculated from the total of the *recorded* cases and deaths during the whole of the War in relation to *the strengths embarked*, which strengths vary materially from the actual numbers exposed to risk. This is unavoidable, as detailed strengths are not available.

(ii) The Imperial Yeomanry were exposed for a less period than the various groups of the Regular Army ; they were not present in any number till the end of March, 1900. The C.I.V.'s were exposed for a still shorter period—from January to October, 1900, only.

(iii) There is, however, probably no serious error in comparing the various groups of the Regular Army with one another.

A.

All Continued Fevers—

	Rates per 1,000 of strength	
	Incidence	Mortality
Household Cavalry	381·8	The mortality is practically
Cavalry	349·8	that of enteric fever.
A.S. Corps..	336·8	
Royal Artillery	326·5	
Imperial Yeomanry	326·5	
R.A.M. Corps	322·6	
Guards	315·4	
Royal Engineers	302·8	
A.O. Corps..	263·2	
Infantry	217·0	
C.I. Volunteers	201·7	
Average	304·05 ± 10·69	
Range	336·07 – 271·93	
Variability	17·3 % ± 2·56 %	

B.

Enteric Fever alone—	Incidence	Mortality
Household Cavalry	291·1	50·43*
A.S. Corps	236·7	34·85
R.A.M. Corps	220·9	28·61
Cavalry	217·3	30·05
Royal Artillery	207·8	28·37
Royal Engineers	204·0	31·25
A.O. Corps	194·3	37·51*
Guards	186·2	25·58
Imperial Yeomanry	139·9	28·37
Infantry	134·5	19·49*
C.I. Volunteers	127·3	23·41*
Average	196·4 ± 9·45	29·86 ± 1·73
Range	224·7 – 168·0	35·05 – 24·67
Variability	23·66 % ± 3·61 %	28·55 % ± 4·43 %

In both tables the incidence rates which are bracketed together are (within the limits of error) indistinguishable. In the mortality table, all the rates except the four starred, are identical within the limits of error.

Considering first the incidence rates for all continued fevers, the same predominance among the cavalry is found to occur that has been recognised in America in the recorded incidence of enteric fever,[1] and in India.[2] At the other extreme we find a comparatively small incidence rate among the infantry, the strongest body in the field. Turning to the table of enteric fever rates, practically the only difference is that the cavalry and Army Service Corps have changed places.

Among the mortality rates, four differ materially from the rest. One, the City Imperial Volunteers, is excluded for reasons stated above, the Army Ordnance Corps show a rate slightly outside the limit, the Household Cavalry a rate largely outside the limit; both these rates however are affected by very large probable errors, and probably the only significant difference in the whole series is the low mortality rate for the infantry. Except for this group, it is hardly possible to say that one corps had a mortality rate which differed essentially from the others.

The lower incidence and mortality in the infantry is very striking, and we have nothing which points to an explanation. The difference may be due, at least to some extent, to their much larger numbers,[3] but the fact noted by Major McCulloch (*loc. cit.*),

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[1] Munson, "Mil. Hygiene," p. 690.

[2] McCulloch, A.M.D. Report, 1900, p. 421, *et. seq.*

[3] The ratios for the Infantry alone in Tables A and B are practically the same as the true ratios for *the whole of the Regulars and Volunteers* as shown in the table—Appendix E.

should be noted—that of the greater incidence in all corps who have to do with animals, possibly through their greater exposure to dirt, dust and fly infection.

(17) *The Results of Anti-typhoid Inoculation.*—The remarks which have been made in the last section relating to the mode of calculation of the ratios applies to the following tables also.

The records of inoculation and of attack or death have been prepared as follows: Nominal rolls by corps were prepared at the time of inoculation, showing the men inoculated. The total on the roll subtracted from the strength embarked gave the number not inoculated. Here we have the strength of the two groups, but it is unfortunate that no more exact detail of the numbers exposed can be obtained, nor of the duration of exposure.

Each case of enteric fever admitted to hospital was written on a card, showing also the result—death or recovery. These cards, assembled by corps, were compared with the nominal roll; the total of the cards corresponding to names on the roll gave the number of admissions and deaths among the inoculated, the remainder, those not found on the roll, gave those among the non-inoculated. From these results the attached table was prepared.

The following summary shows the *aggregate result* :—

C.

	Incidence	Mortality	Case mortality
Non-inoculated ..	208·76 ± 9·98 ..	32·32 ± 2·03 ..	14·34 ± 0·11
Inoculated	100·72 ± 5·81 ..	10·02 ± 1·24 ..	11·50 ± 0·57
Difference	108·04 / 11·54 ..	20·30 / 1·70 ..	2·84 / 0·58
Approximately ..	2 : 1	3 : 1	5 : 4

The case mortality shown here is the mean mortality, *i.e.*, total cases and deaths in each group—inoculated or not—taken as a whole, and is probably nearer the truth than the average shown in the subsequent table (Appendix, G).

The following table shows *the ratio of the incidence among the inoculated* to *that among the non-inoculated* :—

D.

Household Cavalry ..	0·296	Infantry	0·602
Cavalry	0·315	C.I. Volunteers ..	0·483
Imp. Yeomanry ..	0·760	A.S. Corps	0·454
Royal Artillery ..	0·556	R.A.M. Corps	0·651
Royal Engineers ..	0·456	A.O. Corps	0·233
Guards	0·755	Total attacks ..	0·482
		Total deaths ..	0·331

See notes to the complete table on Appendix, G.

The following table shows *the percentage of each corps that was inoculated* :—

E.

Household Cavalry ..	14·98		
Cavalry	7·23		
Imperial Yeomanry ..	4·29	A.S. Corps	1·25
Royal Artillery.. ..	6·44	R.A.M. Corps	11·93
Royal Engineers ..	8·60	A.O. Corps	3·22
Guards	8·43		
Infantry..	3·08	Mean of the whole strength noted ..	4·46
C.I. Volunteers.. ..	56·11		

The table (D) showing the ratio between the incidence among the inoculated and non-inoculated shows considerable variations, and some of the results are hardly trustworthy owing to the small numbers involved, notably the Household Cavalry, Royal Engineers, Army Service Corps, and Army Ordnance Corps.

It is known that the efficiency of the process of inoculation varied in different groups of men. Some were inoculated before embarkation, others on board ship, and sometimes the process was not fully carried out on board the transports. It is not, however, possible to account in this way for the variations in the results of inoculation between one group and another, for the individuals of each group were not invariably separated from one another on the passage out, and the mode of performance of the inoculation on any one transport therefore affected more than one group of men.

Lieutenant-Colonel Sir W. B. Leishman, F.R.S., has been good enough to add the following remarks on the results shown above :—

"As Lieutenant-Colonel Simpson has already indicated the principal fallacies in the above tables, I need only add a few comments upon some points which have not been dealt with by him.

"(*a*) As regards the table showing the ratio of incidence among the inoculated to that among the non-inoculated. It appears impossible, under the conditions prevailing on active service, to secure that there shall have been identical conditions as regards exposure to infection, &c., in the two groups of inoculated and non-inoculated. Information as to the protective effects of inoculation would appear to be more valuable when drawn from a single regiment or unit rather than when compiled from the totals of corps composed of many such units, as has been done in the table—*c.g.*, a cavalry regiment with a large inoculated strength may have been exposed to infection over a long period, while another, with very few inoculated men, may have hardly been exposed at all, and *vice versa*. The statistical results of inoculation might be valuable in each individual regiment where the two groups had been more or less under identical conditions, but the combined figures of the two regiments might prove very fallacious.

"(*b*) The tables do not afford any information relating to the

period which had elapsed between inoculation and attack. In view of the length of the campaign, and in the light of the remarks made in paragraph (*e*) (see below), it is certain that many men who had been inoculated must have outworn their immunity by the time they were attacked.

"(*c*) It is also, naturally, impossible in such tables to take into consideration the facts as to the number of doses of vaccine which the inoculated men had received. It is certain that a considerable proportion only received the first dose and not the two doses which are considered essential to obtain the maximum degree of protection.

"(*d*) No distinction has been drawn between para-typhoid fever and enteric. Anti-typhoid vaccine will not protect against the former, which is now known to be of frequent occurrence in South Africa.

"(*e*) The vaccines used to inoculate the troops during the War were sterilised at a temperature which has been shown by subsequent investigation to be higher than is advisable. These investigations have further shown that the immunity conferred by such superheated vaccines is less in degree, and much more transient, than that resulting from vaccines sterilised at lower temperatures. Viewed from this standpoint it is extremely probable that the various vaccines employed differed in their immunising properties, and that, in the case of some of them, little or no immunity would remain three or four months after inoculation. This would appear to be one of the chief explanations of the comparatively poor results obtained during the War, as contrasted with those recorded in recent times.

"(*f*) It is noteworthy that, in spite of all these factors, the general analysis of the results should show that typhoid was twice as common in the non-inoculated as in the inoculated, and, in my opinion, it is even more striking that, in every corps, without exception, the ratio should have been in favour of inoculation."

CHAPTER XII.

(18) *Conclusion.*—After a careful review of all the conditions associated with the development of epidemic disease, and more especially of enteric fever, it is not possible to be very hopeful with regard to the total abolition of these diseases in the field. Two things are essential—the Army as it takes the field must be free from infection, and it must be maintained free. The first of these propositions presents no insuperable difficulty in the case of an army composed of professional soldiers—*i.e.*, of men of continuous service, constantly under discipline and available for observation; it is merely a question of persistent elimination of carriers. The question becomes enormously complicated by the introduction first of all of soldiers who do not serve continuously, and still more by the employment of civilians, or, what is the same thing, of men specially enlisted to complete establishments. It is absolutely certain that at the time of mobilisation we must take these men as we find them or lose them altogether. So long as we are concerned only with men from this country the danger is relatively small, but when part of our force is drawn from countries in which enteric fever is more widely diffused than in Great Britain, it becomes very much greater, and the next time we put a large army in the field a part of it will again be drawn from these sources. Where natives are employed (as in the transport), the case becomes hopeless as regards the mobilisation of the force free from infection.

Let us suppose that we have succeeded in achieving the impossible—that is, we have placed an army in the field free from all internal infection, say, in our own country. Small as is the incidence of enteric fever in Great Britain, it is sufficient to form a large number of infective foci; and so we have even here a considerable risk of external infection. How are we to avoid the infection of our force, or at least to limit its spread? There is but one external agent (and that giving less than complete protection)—protective inoculation, which must be carried out some time before mobilisation, and probably periodically throughout the service of the individual, whether it is continuous or not. All the rest must be done within the Army itself.

Here, again, no matter what schemes are promulgated, what organisations are developed during peace, in war the basis of the whole framework of effective sanitation is the personal responsibility of each individual of the force. No sanitary scheme will be as effective in the field as it should be until the instincts of the individuals of the force are towards cleanliness in every form; the individual's action must be automatic, and not the result of conscious effort in compliance with instructions.

The only way to ensure this is to stimulate the sanitary sense, or to create it where it is absent, throughout the whole of the population of the Empire. This is of course difficult and will take time, for one of the disadvantages of civilisation is that the individual is relieved of all responsibility for the disposal of his excreta—a condition which does not exist under the barbaric régime of war. The people should understand that the final responsibility for epidemic disease in the field does not rest with the medical service, nor with the Army itself, but with the general population and its instructors in sanitation. We must of course do what we can to render sanitary cleanliness automatic in the Army. This is being done, and without doubt will prove beneficial, but it takes time to ensure that the reflex chain will not break down under the special strain of war.

We have succeeded in the analogous case of personal cleanliness. Custom, discipline, and increasing facilities have made the soldier a clean man—how clean can best be determined by those who have had opportunities of seeing the reserve man or old soldier among his civilian fellow workman. The habit of cleanliness was so fixed, at least in many corps, that it withstood the trials of war; and the soldier was as clean as his officer. We must attain the same standard in sanitary matters. As a general rule, the "smarter" the corps the better is its interior economy, and the higher its standard of personal and sanitary cleanliness. Within the range of one's personal observation, in only one "smart" regiment was the interior economy, the care of the men, below the standard, and that regiment's reputation in the field suffered severely in South Africa.

Behind all these problems of sanitation—that is the protection of the individual from disease and death, lies the question of the effect of this constant war against disease on the spirit of the men. We have, in fact, to teach the man that it is his duty to preserve himself from disease in order that he may have a better chance of being shot. Taking matters on the lower plane, we can of course prove to him that if conditions continue as they were, his chance of death from disease is about twice as great as of being shot, so that he will improve his expectation of life by attention to sanitation. That

however is hardly the point in question, which is whether the constant precaution which he has to observe as a vital unit will not instinctively spread to his militant aspect, and reduce his fighting value. This appears to be analogous to the change in the mental attitude involved in the introduction of the modern attack in extended order, taking advantage of all available cover. No doubt it has been found, here and there, that too great affection for cover developed, but the general result has been shown to be perfectly satisfactory. The quiet, manly soldier of the present day has done as good work as the drunken, dissolute men of Flanders and the Peninsula. When the unremitting individual war against disease becomes subconscious, the effect on the mental attitude of the soldier disappears. Our aim should be to develop the intelligence of the soldier, by no means of a low grade, and without dry-nursing him, to induce a habit of sanitary cleanliness which is as automatic as his response to the word of command on the parade-ground.

Summary.

A. General Results:—

(1) *The total corrected admission-rate* for all causes during the whole campaign was 958 per 1,000 per annum. Of this, 843, or 88 per cent. was due to disease. The weighted mean in twelve of our tropical campaigns for disease admissions was 1,050, or 91·5 per cent. of the total admission-rate. In the South African War the proportion of disease admissions was then less than the average, and the actual admission-rate was considerably less.

(2) *The disease admission-rate*, 843, is made up as follows :—

Fevers	261	*Continued*..	204	*Malarial* ..	57	389
Bowel complaints ..	128	*Dysentery* ..	86	*Diarrhœa*, &c...	42	
Other diseases ..	454					

The group that may be termed "climatic" then accounts for 389, or 46 per cent., and the continued fevers for 24 per cent. of the total disease admission-rate.

(3) *The total mortality from all causes* was (*including killed in action*) 38·09 per 1,000 per annum. Of this, 24·58, or 64 per cent. of the total mortality, was due to disease. This proportion is less than that found in the Crimean War and the first year of the American Civil War. These ratios are largely conditioned by circumstances unconnected with the incidence of disease.

(4) *Excluding killed in action*, the mortality was 28·5 per 1,000, of which disease contributed 24·58, or 86 per cent., which is the proportion found in our previous campaigns.

(5) *The disease mortality*, 24·58, is made up as follows :—

Fevers	18·31	*Continued*..	18·11	*Malarial* ..	0·20	21·38
Bowel complaints..	3·07	*Dysentery* ..	3·02	*Diarrhœa*, &c...	0·05	
Other diseases ..	3·20					

The "climatic" group accounts for 21·38, or 87 per cent; the continued fevers (practically enteric fever alone), for 74 per cent. of the total disease mortality. The mortality from dysentery alone equals that from non-climatic diseases.

(6) *The predominance of the epidemic diseases*, the continued fevers and dysentery, confirms the experience of former campaigns, but in the South African War the proportion of admissions from these two causes was relatively low; the proportion of the disease mortality was about the average.

(7) *The case mortality of enteric fever* was very much lower than the average case mortality over twelve campaigns, 13·90 per cent. as against 29·85 per cent., or certainly less than half. *The case mortality for the whole of the continued fevers* was slightly less—8·87 per cent. against 9·92 per cent.

(8) *Of the total continued fevers* admitted to hospital, nearly two-thirds (63·5 per cent.) were diagnosed enteric fever, an unusual proportion, and taking the evidence of the case mortality into consideration, the conclusion is that *in no previous campaign has enteric fever been diagnosed so freely*, and that *our admission-rate in South Africa must be reduced by at least one-third to make it comparable with those in other campaigns.*

(9) *Protection against enteric fever* by previous exposure, infection, and attack was evident as between the various classes of which the Army was composed, except under conditions of exceptional severity.

(10) *Dysentery* showed in a lesser degree the same variation from group to group as did enteric fever.

B.—Causes Contributing to Prevalence:—

(1) Enteric fever and dysentery were endemic and occasionally epidemic throughout the whole area of operations before the War.

(2) Such methods of sanitation as existed were, at the best, very imperfect.

(3) The operations took place almost entirely within the area of the summer rains, where enteric fever is always more prevalent than elsewhere.

(4) The composition of the force was exceptional; 55 per cent. of the total embarked was almost entirely without any acquired immunity against enteric fever.

(5) The sanitary organisation of the Army was not adapted for the requirements of the situation, largely owing to the small proportion of the trained officers of the Royal Army Medical Corps.

C.—The Mode of Development of the Continued Fevers :—

Where it has been possible to obtain particulars of the prevalence in large, isolated bodies of men at the beginning of the campaign, the following features were common :—

(1) A very slight irregular development lasting about eight weeks from the beginning of exposure, followed by

(2) A period of sudden and sharp development to a maximum, lasting about four weeks, followed by

(3) A decline, more or less well marked, and by later recrudescence of disease.

(4) A very sharp distinction from the mode of development of bowel complaints, except in the case of Ladysmith.

(5) After June, 1900, the prevalence of enteric fever was general, but no great epidemics occurred.

D.—The Mode of Development of Dysentery and Diarrhœa :—

(1) These show an early and rapid development *immediately* after exposure.

(2) Except in Ladysmith, their general prevalence was not at any time comparable with that of the continued fevers.

(3) Except in Ladysmith, there was no tendency to excessive prevalence at certain periods; on the other hand there was a limitation in the degree of development.

(4) Dysentery was the predominant type throughout; except at Modder River and Bloemfontein it appeared earlier and in greater proportion during the first weeks of exposure.

E.—The Propagation of Epidemic Disease :—

(1) Antecedent foci of infection existed when the troops took the field. Numerous other foci were established after their arrival.

(2) The modes of dissemination included practically every known method.

(3) Opportunities for water infection were numerous; they probably contributed to the total of the infections, but their influence in the spread of disease appears to have been secondary to

(4) Contact infection, direct from man to man, or more remote through latrines, &c.

F.—Accessory Influences :—

Their effects were obscured by the more potent influences at work.

G.—Protective Inoculation against Enteric Fever :—

(1) The aggregate results show a diminution in the inoculated cases as follows: Incidence about one-half, mortality about one-third, case mortality about one-fifth.

(2) In the same corps the recorded incidence among the inoculated was always somewhat less than among the non-inoculated.

The statistics, however, are affected by considerable error.

PART III.

CHAPTER XIII.

Other Diseases.

(1) Up to this point, attention has been entirely directed to the general conditions affecting the incidence of disease, their results as shown in that incidence, and the special features of the development of the two epidemic diseases, with the lessons to be learned from them. It is now proposed to add a few notes on the other aspects of those "climatic" diseases shown by name in the tabular summary on p. 51, and to consider in some detail the diseases grouped together in that summary as "other diseases," so far at least as they may prove interesting and instructive.

Enteric and simple continued fever form the subject of a special study by Colonel H. H. Johnston, C.B., and will not be referred to in this place.

(2) *The Collection of Material.*—After the War, in order to make use of the experience which had been obtained in the field, a Committee was formed of officers who had had large personal experience during the campaign, whose duty was to collate all the available information and furnish a series of reports on such diseases as seemed to them important. These officers were Lieutenant-Colonel G. Coutts, Lieutenant-Colonel Culling, Majors H. B. Mathias, D.S.O., F. Smith, D.S.O., W. W. O. Beveridge, D.S.O., and W. F. Erskine. Much use has been made of their reports in what follows, and where possible, the source is directly indicated.

In addition to this, efforts were also made to obtain from the medical officers who had served in South Africa (both of the regular forces and the civil surgeons) statements of their experiences, but this met with very little success, due no doubt to several causes, of which one may mention: the pressure of other work, the desire for more immediate publication than was probable in a work more or less official, and in many cases to a desire, not unnatural, to hear no more of the War. It may also be pointed out that much had been published before the conclusion of the War, and that for the two or three years following its conclusion a good deal appeared in

the general medical press. But a few very useful reports were received, some of which have already been used in the surgical history of the War.

In the following notes, only those points which appear to be of interest will be referred to; no attempt will be made to offer a complete account, which in the present state of knowledge is quite unnecessary.

(3) *Dysentery.*—Corrected incidence, 85·81. Mortality, 3·02 per 1,000.

(*a*) *Etiology.*—Much has been done since the period of the South African War. What could be said about South African dysentery at that time will be found in the section of the Report of the Commission on Dysentery and Enteric Fever in South Africa contributed by Colonel Sir David Bruce, F.R.S. From the clinical side, the important parts of his results are that, "dysentery in South Africa is not caused by amœbæ," and that "there is a certain amount of evidence to show that so-called cases of dysentery following enteric fever are relapses of enteric, where the disease has attacked the large intestine." At the same time, it may be pointed out that as a considerable number of men came from India, it is quite possible that, in the first place, a few cases of amœbic dysentery (contracted in India) may have been introduced into South Africa, and it is even possible that a limited infection may have taken place from them, though no such case came under the observation of Sir David Bruce. Lieutenant-Colonel C. Birt (*Brit. Med. Journ.*, November 9th, 1907, p. 1336) found one case of amœbic infection in fifty-five cases of dysentery.

(*b*) The epidemiological relations have been dealt with already. It may be pointed out that the great variations in temperature were probably efficient in producing relapses rather than fresh infections. Further, as the War went on, the teeth of the individuals of the force became more and more inefficient, and this with the prevalent oral sepsis, and the somewhat intractable field ration, tended to produce a state of chronic irritability of the bowel, which assisted the process of infection.

(*c*) *Varieties of the Disease.*—Previous experience in South Africa showed that the endemic dysentery, not uncommon, was of a mild type and rarely fatal. The mortality between 1859-73 was 0·66 per 1,000 of strength, and between 1884-98 but 0·30. The following case mortalities are useful for comparison :—

	Cases	Deaths	Case Mortality
S. Africa, 1886-98	758	16	2·11 ± 0·35
India, 1908	986	29	2·91 ± 0·86
10 campaigns*	3,053	124	4·06 ± 0·21
S. African War	38,108	1,342	3·52 ± 0·06

* Shown in the table Appendix C.

The case mortality in war is slightly higher than in peace, but the difference is not very great, and the only difference which is of real significance is that between the peace and war rates in South Africa. The comparison of case mortalities in dysentery is, of course, extremely unsatisfactory as a means of comparing types of disease, as so much depends on the proportion of the relapse cases to the fresh infections. In South Africa, experience before the War seemed to show that not only was the type of disease less severe, but relapses were much less common than in India ; this comparative freedom from relapse probably did not continue during the War.

Where the number of cases admitted to hospital was as great as that which occurred in South Africa, anomalous cases were to be expected, and a certain number of these did occur. Such cases, however, are rather of the nature of curiosities, and it seems better to confine attention to the more usual forms, of which every variety was found. The following report by Lieutenant-Colonel G. Coutts and Major F. Smith, D.S.O., gives all that is necessary for the comprehension of the disease condition met with during the War :—

"Dysentery was usually preceded by diarrhœa of a somewhat acute type, characterised by much griping pain, copious watery evacuations, and a moderate amount of debility. This diarrhœa was generally cured by a few days' rest and dieting, and was distinct from the premonitory diarrhœa of dysentery itself.

"*Symptoms.* — The symptoms observed in South African dysentery were those usually described in epidemics elsewhere, except that there were, as already noted, a large number of very mild cases, which recovered after a few days' rest and a milk diet. In them the stools, although characteristic, were not numerous, and the pain and straining were often insignificant. The preliminary diarrhœa was observed, as a rule, but in some patients the dysenteric stools followed immediately on a condition in which the motions were composed of scybalous masses mixed with mucus, pale or blood-stained. In severe cases the stools were very frequent, were composed wholly of blood and mucus, and were passed with much pain and tenesmus. In bad cases hæmorrhage was not uncommon. In his report on No. 6 Stationary Hospital, Green Point, Lieutenant-Colonel H. O. Trevor remarks, that 'hæmorrhage over and above the blood-stained mucoid stools common in the disease was a feature' of the dysentery treated in that hospital. Greenish-coloured motions were sometimes seen, and in fatal cases the dejecta often lost their mucoid character, and resembled dirty water mixed with shreds and sloughs.

"The pain varied from slight griping and a feeling of soreness in the abdomen to acute agony ; it was often located about midway

between the umbilicus and the pubes, and was then of considerable diagnostic value. Pain of a burning character in the rectum was not uncommonly a symptom. In most cases of any severity tenderness was present over some part of the great bowel. Pain over the liver was noted in a considerable number of cases, with tenderness and enlargement of that organ. Strangury is frequently mentioned. Vomiting and hiccough complicated severe and fatal attacks, in which tympanites, profuse perspirations, and collapse were frequent terminal symptoms.

"Unless when it occurred at the commencement of an attack of enteric fever (a common event), dysentery was accompanied by an amount of pyrexia which was mild in comparison with the severity of the other symptoms.

"*Diagnosis.*—The inspection of the stools as an indispensable preliminary to correct diagnosis is not always easy on service in the field, but in view of the importance for successful treatment of early recognition of the disease, and from the fact that the patient's statements are often erroneous, it should never be omitted.

"The only conditions likely to complicate diagnosis in this respect were piles, constipation with the passage of mucus, and possibly rectal bilharzia; cancer of the rectum, for obvious reasons, was not a factor.

"A large number of patients was admitted to the hospitals for dysentery which merged into enteric fever, the latter running its usual course after the former had subsided. In these cases, apparently, both diseases were contracted at or about the same time, the dysentery manifesting its distinctive symptoms first, possibly on account of a shorter incubation period. The associated dysentery appeared to be of the catarrhal variety, and to yield readily to treatment, but it naturally added somewhat to the gravity of the prognosis.

"Men who were apparently convalescing from enteric fever not infrequently developed symptoms, which were often regarded as those of dysentery. But, as has been shown by Colonel Sir David Bruce, F.R.S., the dysenteric symptoms in such cases were, for the most part, due to an extension or recrudescence of the typhoid infection in the large intestine; although it is, of course, possible that a true dysentery followed an attack of enteric fever."

Major Erskine states that in Natal "with increasing frequency of the griping, straining, and diarrhœa the stools became more mucous in appearance and then acquired a sanious colour, but, the *amount of blood or shreddy mucus observed was never so great as seen in the form witnessed on active service in India.*"

(*d*) *Pathological Conditions.*—The following extracts from the same report deal with certain unusual points:—

"In the great majority of cases the dysenteric process was confined to the large bowel, but in a few it overstepped the ileo-cæcal valve, and involved the lower 5 or 6 inches of the ileum. In one remarkable case, described by Major Beveridge, the stomach presented the same appearances as the large intestine.

"The case which was treated at No. 19 General Hospital, Pretoria, in May, 1901, under the care of Captain Anderson, D.S.O., is thus described:—

"'A serjeant of the Royal Garrison Artillery was admitted to hospital suffering from a very severe attack of acute dysentery, and developed great distension with much vomiting, hæmorrhage, and abdominal pain (referable to the area of the stomach), from which he died.

"'On *post-mortem* examination it was found that not only was the colon the seat of extensive ulceration, but the stomach itself was in a similar condition. The mucous membrane was deeply infiltrated, granular, and undermined with extensive ulceration; in fact a typical dysenteric condition.

"'The case was of particular interest, as it led to various opinions in regard to diagnosis, but dysenteric ulceration of the stomach was never suspected before death.'

"Since observing the above case Major Beveridge reports that he has carefully examined the stomach in every fatal case, and has met with a similar condition in many instances, but not to the same marked extent. The parts affected were patches in the neighbourhood of the orifices and along the greater curvature, the condition varying from a gelatinous, granular infiltration, to marked ulceration.

"*Perforation.*—Perforation of the large intestine was occasionally found, mostly on *post-mortem* examination. It was met with in two out of 640 cases of dysentery in No. 20 General Hospital. In both of them the site of perforation was the posterior part of the cæcum. An abscess formed in each case, and was evacuated by an operation similar to that for appendicitis; one patient recovered, the other died. At the *post-mortem* examination it was found that another perforation had taken place at the hepatic flexure of the colon, an abscess had formed between the colon and the liver, and other small abscesses were interspersed throughout the hepatic substance.

"At No. 17 General Hospital, two fatal perforations were noted among 2,336 cases of dysentery—both in the lower end of the bowel, and accompanied by peritonitis. A third case in which there was a small abscess of the right iliac fossa, as well as many in the liver, is not noted among the perforations, but may have been similar to those reported from No. 20 General Hospital.

"In a fourth case also under treatment in this hospital the patient, Lance-Corporal E., aged 32, service twelve years, was admitted on December 28th, 1901, with a history of dysentery for about fourteen days. He was incessantly purged and was passing much blood and mucus. Under treatment with magnesium sulphate the stools decreased in number, but he still continued to pass blood, and on February 4th, 1902, signs of perforation appeared and he died the same day.

"On *post-mortem* examination a perforation was found in the cæcum. The whole colon was extensively ulcerated and sloughy. The small intestine and liver were normal.

"At No. 2 General Hospital perforation with peritonitis occurred in four cases out of 1,036. The cæcum alone was perforated in two, cæcum and ascending colon in one, ascending colon in one.

"There was also a case of cæcal abscess (probably following perforation) among the officers, which is described as follows by Lieutenant-Colonel Sylvester, R.A.M.C. The patient, an officer of Irregulars, of very poor physique, was transferred to No. 2 General Hospital at the end of May, 1901. He had had dysentery in Natal in 1900, and for a month had been complaining of pain about the cæcum, where there was some tenderness, but no swelling to be made out.

"Towards the end of June a swelling appeared over the liver just under the ribs and aspiration drew off pus. On July 7th the abscess was opened, and a large cavity found extending downwards between the ribs and liver, the substance of which was eroded. A counter-opening was made in the ninth intercostal space in the axillary line, and a large quantity of chocolate-coloured pus evacuated. The discharge from this abscess gradually diminished, but at the end of August a painful swelling appeared over the cæcum. This was explored on September 12th, and a mass of inflammatory tissue found on opening the peritoneum, but no pus. Next day, however, fæcal-smelling gas came from the wound, followed by pus and fæcal matter. After this there was a constant discharge of fæces from the wound; he became gradually weaker and extremely emaciated, and died on January 13th, 1902.

"*Post mortem*.—It was found that the cæcum had been practically destroyed by dysenteric ulceration posteriorly, and an abscess had formed which had tracked up behind the ascending colon, and then come forward below the liver and between it and the ribs. It had also burrowed into the pelvis, and through the obturator foramen into the thigh.

"At No. 4 General Hospital perforation was found in two cases, there being three perforations in the lower part of the bowel

in one, and one perforation, 12 inches below the cæcum in the other.

"A case is reported from No. 7 General Hospital, in which there were two perforations below the ileo cæcal valve; another from No. 10 General Hospital, in which the gut was ruptured in the lower part of the descending colon. This was the case of Private A. H., aged 34, admitted on April 16th, 1900, with acute dysentery. The stools were very frequent, consisted mainly of blood and mucus, and were accompanied by much pain and tenesmus. Under treatment they became more feculent, but continued frequent; the patient became very exhausted, and the temperature subnormal, and on April 30th he fell into a state of collapse and died.

"At the *post mortem* there was a perforation in the lower part of the descending colon, permitting escape of bowel contents. The whole of the large intestine was inflamed and softened, but also presented the marks of old healed ulcers. The right lobe of the liver contained about fifteen small abscesses the size of a pea.

"A case was under treatment in No. 18 Stationary Hospital, Krugersdorp, in which a chronic ulcer in the splenic flexure of the colon had given way, and led to the formation of a large abscess behind the stomach.

"The large proportion of cases in which the first portion of the great bowel was perforated is noticeable; this accident being, according to the above figures, about twice as common in the cæcum and its neighbourhood as in the lower part of the bowel.

"Localised peritonitis causing adhesions of the large intestine to neighbouring organs was not uncommon."

Perforation is not a common complication of bacillary dysentery. Vaillard says:[1] "Si la perforation est très rare dans la dysenterie des climats tempérés, elle l'est beaucoup moins dans celle des régions tropicales et surtout dans la dysenterie amibienne." Ruge,[2] in a footnote to a report on dysentery from Tientsin by Haasler, points out that the not uncommon occurrence of deep ulceration producing perforation and peritonitis points to an amœbic infection, possibly with a bacterial infection also.

"Hæmorrhage occurred in a considerable number of the severe forms of dysentery in which extensive ulceration and sloughing of the bowel were found on *post-mortem* examination. It is mentioned as the immediate cause of death in one patient under treatment at No. 2 General Hospital."

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[1] "Nouveau Traité de Médecine," vol. vi, p. 252.

[2] Mense's "Handbuch."

(*e*) *Septicæmic or Pyæmic Complications*:—

"An articular affection[1] was noted as an occasional complication. Two cases were mentioned in the report of No. 2 General Hospital, in one of which the knee- and ankle-joints were enlarged but not painful; there was but slight exacerbation of the temperature. In the other, the onset of the joint affection was accompanied by a slight relapse of the dysenteric symptoms. The part first affected was the metatarso-phalangeal joint of the great toe, and it resembled an attack of gout. In rapid succession both knees and both ankles were attacked. There was a good deal of pain and some fever. Treatment with salicylates was ineffectual, but the swellings gradually subsided. A few similar cases, where several joints were affected, occurred in other hospitals.

"Cultures obtained in this and four similar cases, examined by Major W. W. O. Beveridge, D.S.O., showed the presence in the blood of the *Staphylococcus pyogenes albus*. He states that in all the five cases blood was taken with the strictest antiseptic precautions, during the continuance of the fever and swelling, and between the second and eighth days, and in all the microbe was obtained in pure culture.

"As a control, blood was taken from cases of dysentery which showed no complication of this nature, and in each case the blood was sterile. The cultures were made in each case on agar and blood serum.

"A case is recorded at No. 2 General Hospital as having been treated for enteric fever, in which, at the *post-mortem* examination, abscesses were found in the brain, lung, and liver, and the large intestine showed the presence of old dysenteric ulceration.

"Pericarditis with effusion was found in a few cases, and as a rare complication the cardiac valves were affected in the course of an acute attack, a septic ulcerative endocarditis supervening.

"(*f*) *Treatment.*—In approaching the subject of the treatment of dysentery, it is important to remember that the disease, in its early stages, is very amenable to efficient medication, whereas the complaint, when firmly established, is apt to be very intractable, and to result in chronic ill-health and death. Observation of the general run of dysentery cases admitted to the hospitals during the campaign, appeared to show that the importance of early diagnosis

[1] This articular affection is not common in the cases seen in the Service. Ruge, however, points out (Mense's "Handbuch") that it is the most frequent complication of bacillary dysentery, even in the mildest cases. Vaillard says that these attacks are not rare. Dantec points out that they are due to secondary infections and do not differ from the arthropathies found in other diseases, such as small-pox and scarlet fever; the proportion of such attacks varies in different epidemics.

was perhaps scarcely sufficiently appreciated by the mass of medical men. The need for the early recognition of enteric fever was more generally admitted, although it would seem that prompt diagnosis is less urgently required, as regards immediate drug treatment, than in the case of dysentery.

"It is true that the nature of the operations, the enormous tracts of country over which they were spread, and the conditions under which the sick had to be transported, interposed formidable obstacles to the early and efficient treatment of dysentery patients. But the importance of rest in bed, suitable food, and early drug treatment, sufficiently well known before to experienced medical officers, was often, for the above reasons, unavoidably demonstrated by the deplorable condition of those patients who had to make long journeys (from Paardeberg, for instance, to Modder River or Kimberley), before reaching the shelter of the stationary hospitals, and for those patients, as well as the victims of enteric fever and other acute diseases, there can be no question of the advantage that would accrue if fully-equipped hospitals could be brought within easy reach of the troops in the field.

"Apart from the dietetic treatment of dysenteric patients, two main lines of medicinal treatment were followed during the campaign, those, namely, of ipecacuanha and salines. Both are time-honoured remedies, although it is uncertain to which priority is due. They are both mentioned by Sir John Pringle and Donald Munro, who practised as Army surgeons some one hundred and fifty years ago.

"Ipecacuanha, which has been used successfully by generations of physicians in India, was held, for the most part, to have failed in South Africa. Yet, where the patient was treated as well as the disease, a certain measure of success attended its administration in the hands of some medical officers. Lieutenant-Colonel Ferguson, C.M.G., who was stationed at Waterval Onder, says that 'Ipecacuanha in 20-grain doses night and morning, with complete rest and plain milk diet, effected a marked improvement in a couple of days. Only on two occasions did the specific effect of this treatment appear to be delayed. The saline treatment was never resorted to.' In his report on dysentery in No. 4 General Hospital, Colonel Johnston remarks that 'a saturated solution of magnesium sulphate was much in favour, but the results obtained did not appear to be so good as those of ipecacuanha, with all due precautions taken to prevent nausea and vomiting, and in some cases in which the former method of treatment failed, and the patient's condition was becoming serious, the administration of large doses of ipecacuanha brought about a speedy recovery.'

"On the other hand, the Officer in Charge No. 17 General Hos-

pital, Standerton, reports that 'ipecacuanha, which is a specific in Southern India, is a failure in South Africa.' The best treatment was 'the free use of salines combined with morphia, at night, to secure rest and sleep.' The use of magnesium sulphate alone, or in combination with the soda salt, was followed by speedy recovery in a large proportion of the cases. It was commonly given in drachm doses every hour for thirty-six or forty-eight hours, the therapeutic effect being, apparently, to irrigate the bowel, and to replace the blood-stained mucoid stools by normal feculence.

"To explain this discrepancy in the results of treatment, it has been assumed that different forms of dysentery were met with. Thus, Lieutenant-Colonel Twiss, in charge of No. 20 General Hospital, was of opinion that many of the cases treated were mere catarrhal inflammation of the lower bowel, and that they were distinct from the real dysentery of other tropical and sub-tropical countries. In the former class of cases, a cure was, as a rule, easily effected by castor oil or salts; 'in the latter, the disease defies these, and often ipecacuanha,' as well as other forms of treatment.

"Major Beveridge adopts this view, remarking that the reason why so many medical officers were inclined to doubt the efficacy of ipecacuanha, was due to its being applied as a routine practice, without regard to the different types of the disease. He continues: 'In my experience ipecacuanha in the large doses given with such good effect in tropical dysentery was only of value in those cases which were clearly of amœbic origin, and, as a rule, entirely failed in the ordinary bacillary type.' But, as already stated, the existence of the amœbic form of dysentery in South Africa is very doubtful.

"He adds that ipecacuanha sine emetine is valueless in these cases, as are also small doses of ipecacuanha, which must be given in doses of 20 or 30 grains, and repeated if necessary. Major Smith, D.S.O., on the other hand, reported that he obtained good results with the tablets of ipecacuanha sine emetine, and it is possible that a too sparing use of the drug, with or without the emetine, accounted for some of the failures.

"Major Beveridge, speaking from an experience of the treatment of over 500 cases of South African dysentery, and the trial of various remedies, recommends the following combination as giving the best results in what he calls the 'bacillary' type of the disease:—

Pulv. ipecac. co.	gr. x.
Bismuth subnit.	gr. xx.
Salol	gr. x. to xv.

"This is given three- or four-hourly, according to the severity of the case, and he finds that it relieves distension and tenesmus, and quickly reduces the number of stools.

"He is not in favour of sulphur, which was largely prescribed at one period of the War and highly spoken of by some, being of opinion that it is apt to cause distension, and from its granular nature is liable to irritate the ulcerated bowel. He states that at *post-mortem* examinations he found the ulcerated surface of the colon covered over in patches with a layer of granular deposit of sulphur and sulphides.

"Solution of mercury perchloride was prescribed by some on account of its supposed antiseptic action on the intestinal tract, and izal in combination with bismuth found favour with others, but as far as can be judged from the notes of cases so treated, these drugs were of doubtful value. *Monsonia ovata* was favourably reported upon by Major Moffet at Norvals Pont, but is said to have proved unsuccessful by the medical officer in charge of No. 19 Stationary Hospital at Harrismith. It was much used in Natal, but did not seem so useful in the Transvaal.

"From a critical examination of the details of drug treatment in dysentery, given in the records of the hospitals, we are inclined to think that the rest and warmth of bed, milk diet, and a purgative to thoroughly clear out the intestinal tract, were the main elements of success in the ordinary run of cases.

"Where the disease assumed what may be called a malignant type with much ulceration, suppuration and sloughing of the inner coats of the bowel, drug treatment by the mouth was apt to fail, and irrigation was then had recourse to, with solutions of boracic acid, Condy's fluid, nitrate of silver, &c.

"The paramount importance of rest in bed, suitable dietary and early medicinal treatment are, as regards the treatment of dysentery, the main lessons of the War; and to these may be added a skilful selection of remedies to suit individual cases, and an avoidance of routine treatment.

"As regards dietary, some difficulty was experienced, in the earlier stages of the campaign, in procuring an adequate supply of fresh milk, but preserved milk formed an efficient substitute, and in course of time, arrangements were made for the constant supply, to stationary hospitals, of the fresh article in fair abundance. Civil Surgeon W. Rous Kemp, employed at No. 4 General Hospital, Mooi River, strongly recommends the white of egg as a valuable food in very severe cases with frequent stools, tenesmus, and vomiting. The white of one egg was beaten up and mixed with one large bottle of soda water, as many as twelve or eighteen eggs being used in the twenty-four hours. No milk or brandy was given, as the latter had a tendency to increase diarrhœa, and the former to cause sickness. When the stools became less frequent, raw beef juice, with an ounce of port wine added, was allowed three times

a day, in addition to the white of egg. Lime juice sweetened with sugar and diluted with soda water, was given as a beverage.

"The segregation of dysentery patients, the disinfection of their clothing and bedding, and the destruction or disinfection of the excreta, were, as time went on, as carefully attended to, in stationary hospitals, as in the case of enteric fever. The occurrence of dysentery in patients under treatment for other diseases suggested the necessity of these precautions, which must now be regarded as necessary elements of success in the prevention of epidemics of the disease."

It was frequently assumed in South Africa, as it is still assumed elsewhere, that the success or failure of the normal treatment with ipecacuanha was sufficient to determine the diagnosis of amœbic or of bacillary dysentery. This is not, however, a sufficient means of diagnosis. There is little doubt that in India, ipecacuanha has what one must term a specific action in amœbic dysentery, of which the strongest evidence is in the success of Roger's method of treating the early stage of hepatic abscess.[1] Also as there is a special "Brazilian" method of administering ipecacuanha, it may be assumed that it is exceptionally useful there also. But this is not always the case. Ruge,[2] whose experience is apparently chiefly on the West Coast of Africa, points out that ipecacuanha is to be avoided, and quotes J. H. Ford,[3] who states that under some conditions, the administration of ipecacuanha in such cases may be directly fatal. As a matter of personal experience in Natal before the War, ipecacuanha did not give those satisfactory results which one would expect in India.

It must not be forgotten that while amongst us, the choice is habitually between ipecacuanha and sulphates, the German and French schools use other modes of treatment for both forms of infection and with good results.

It would be difficult to say whether or not a "catarrhal inflammation of the lower bowel" was a true dysenteric infection or not without bacteriological examination. There do not appear to be any valid grounds for making this distinction in view of the innumerable infections which may cause the group of symptoms which we term dysentery.

(4) *Hepatic Abscess.*—(*a*) The following table shows the numbers of cases of hepatic abscess and hepatitis recorded by us compared with the admissions and deaths from dysentery :—

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[1] Leonard Rogers, "Fevers in the Tropics," &c.

[2] *Loc. cit.* [3] *Journal of Tropical Medicine and Hygiene.*

Group	Dysentery		Hepatic Abscess		Hepatitis		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Regulars and Volunteers	31,287	1,106	150	77	633	16	783	93
Imperial Yeomanry ..	2,591	90	9	7	23	0	32	7
Colonials	4,230	147	25	13	68	1	93	14
Total	38,108	1,343	184	97	724	17	908	114

The corrected mortality per 1,000 for *hepatic abscess* and *hepatitis* taken together is as follows:—

Regulars and Volunteers, 0·27; Imperial Yeomany, 0·28; Colonials, 0·17; Total, 0·26.

These two pathological conditions must be taken together in order to get results comparable with those in South Africa before the War, as follows: 1859-73, 0·55 per 1,000; 1884-98, 0·38 per 1,000.

The mortality from *hepatitis* and *hepatic abscess* was then less during the War period in South Africa than during the preceding years. The influence of alcohol is so marked in the production of this complication, that there is probably no error in attributing the diminution, in part at least, to the increasing sobriety during the later years of the century, and especially to the general abstinence obtaining during the War period.

Taking the deaths from *hepatic abscess* in relation to the total deaths from dysentery plus hepatic abscess, we find in the Regulars and Volunteers the proportion is 1 in 15; in the Imperial Yeomanry, 1 in 14; in the Colonials, 1 in 12; and over the whole, 1 in 16.

For comparison, Waring found in India an average proportion (of hepatic abscess in fatal cases of dysentery) of 1 in 4·2; Fayrer, 18 per cent., or rather less than 1 in 5; Hirsch, by collating the available statistics, 19·2 per cent., or about 1 in 5; MacCallum (Baltimore), 1 in 4·2.[1]

There are several fallacies in the statistics relating to hepatic abscess. In the first place, the return of a fatal case, where the treatment in hospital has been continuous, may be under the heading of the primary disease, dysentery, or the complication hepatic abscess; there is not sufficient uniformity of practice in this respect. Again, where abscess is found in the liver at the autopsy, where, however, it has not been the immediate cause of death, it usually fails to take its place in the statistical returns. Hence as the deaths from dysentery in this way usually contain some in which hepatic abscess actually existed, the proportion of

[1] W. G. MacCallum, Mense's Handbuch.

this complication is usually recorded as rather less than the actual results. Under peace conditions, over a large area such as India, this perhaps adjusts itself, and different periods are comparable. Conditions were somewhat different in South Africa, autopsies were by no means so common as in India, and probably some of the cases of abscess failed to be recorded on this account.

But, allowing for these fallacies, the proportion of hepatic abscess to the total deaths from dysentery must have been much smaller than in India, certainly not exceeding one-half, and probably even less than that.

Lieutenant-Colonel Coutts and Major Smith make the following remarks :—

"(*b*) The liver in severe cases of dysentery was often enlarged and fatty; in some there was perihepatitis with glueing of the organ to the diaphragm and neighbouring viscera; but the most striking phenomenon in connection with the liver was the presence of abscess.

"An idea prevailed in the earlier part of the War, that liver abscess did not occur in the dysentery of South Africa, but this was very far from being the case. The frequency of its incidence is difficult to estimate, owing to the fact that in a large number of fatal dysenteries the liver was not examined. The report of No. 2 General Hospital, for example, mentions only seven instances in which liver abscess occurred, out of a total of 2,172 dysenteric patients; No. 19 Stationary Hospital, Harrismith, at most five among a total of 705 ; No. 4 General Hospital, twenty-two in a total of 1,605, while the report of No. 14 General Hospital, Newcastle, states that among 822 cases of dysentery with twenty-two deaths, abscess of the liver supervened in only one or two instances, and Major Moffet, writing of Orange River, where he had 402 admissions for dysentery, says, that he did not see a single case of abscess of the liver.

"On the other hand, in fifty-seven cases of dysentery, collected from various sources, and in which a necropsy was made or (in a few instances) pus found by operation on the liver, abscesses were found in thirty-six. These figures doubtless overstate the incidence of liver abscess in dysentery; *post-mortem* examination would be likely to be held more frequently in cases which were complicated with symptoms of liver mischief than in those that appeared to be uncomplicated, but even in the latter the small multiple abscess might exist without giving rise to symptoms. Indeed the records expressly state that small abscesses were found *post mortem*, which had not been suspected during life.

"The abscess was in the majority of cases the multiple, or so-called pyæmic form. Of the thirty-six cases above mentioned, not

more than six were single; in the remainder the number varied from two to 'myriads.'

"As regards size, they varied from a pin's head to a condition in which the liver (in one case) was described as a 'bag of pus,' the wall of the abscess being composed of softened liver tissue about half an inch in thickness.

"The size of the multiple abscesses most commonly met with was about $\frac{1}{4}$ inch in diameter; they were mostly circular, and their contents consisted of necrotic liver cells, and some yellow or greenish-coloured pus. A common condition was the existence of one or more abscesses of considerable size, with a variable number of smaller abscesses. The genesis of the multiple abscess is generally explained on the assumption of a secondary invasion of pyogenic cocci, although, according to Major Beveridge, the *Bacillus coli communis* is also responsible for their presence.

"The following is Major Beveridge's report of the microscopical examination of these abscesses:—

"'There is no formation of an abscess wall.

"'The suppuration evidently begins in the periportal connective tissue, the pus frequently being of a yellow to greenish hue, and may contain particles of pigment.

"'The liver tissue around is compressed, and the hepatic cells enlarged and granular, or in a necrotic condition.

"'The contents of the foci consist of pus cells and necrotic liver cells, amongst which can be detected small masses of micrococci or colon bacilli. The outline of the abscess cavity has no definite structure, and is surrounded directly by the necrosed liver tissue, which presents a ragged outline towards the abscess cavity.

"'Externally the liver substance is infiltrated with leucocytes.'

"As already pointed out, the existence, in South Africa, of a so-called tropical form, due to amœbæ, is very doubtful. In the few cases, which were examined microscopically and bacteriologically, the amœbæ were rarely found, and the pus was sometimes sterile, but the amount of work done in this direction was too limited to justify any conclusion either way. Judging, however, from the broad facts of naked-eye pathology, it seemed possible that all liver abscesses were the result of one and the same process. The smaller form of abscess varied greatly in numbers and position, and where one or two large abscesses were found, it appears feasible to suppose that owing to diminished virulence, or increased resistance on the part of the patient, the morbid action was limited to one or two areas of the liver, which by gradual enlargement of separate foci of suppuration were broken down into large cavities."

(*c*) Several points may be noted in relation to the nature of these abscesses. The fact that multiple abscess was the pre-

dominant type does not of itself exclude an amœbic origin, for although the solitary abscess is the classical type, it is now known that amœbic infection may produce an exceedingly large number of foci, and in addition, the duration of the case and surgical interference by an open operation have an important influence in increasing the chance of a secondary, bacterial infection.

On the other hand, in reading over the reports of the cases, the frequency of severe ulceration of the bowel is striking. As has been pointed out by Davidson and others, the true pyæmic abscess appears to be most common in cases with extensive ulceration. In sixty-one cases reported by Davidson,[1] nine non-dysenteric cases showed a definite portal phlebitis, the remaining fifty-two showed various lesions of the gastro-intestinal tract or its annexes, and of these, thirty-seven were consequent on dysentery.

On the whole, the prevalence of hepatic abscess gives little assistance in determining the degree to which amœbic infection existed in South Africa, but taken with the comparative frequency of perforation, it suggests that amœbic infection was perhaps less rare than the bacteriological findings appear to show.

(5) *Malarial Fevers.* — Corrected incidence, 56·64; mortality, 0·20 per 1,000.

There is little to be said about malarial fever in South Africa. In Cape Colony, and the Orange River Colony, there are no infected localities. In Natal and Zululand, the coast-belt is infected; it, however, formed part of the area of operations only for a very short time. The greater part of the Transvaal is also free from infection, but the Krokodil Valley below Waterval Onder was highly infected, while Barberton and the De Kaap valley are infected to a less degree. The bushveldt north of Pretoria and part of the country north of the line to Delagoa Bay were also infected. The contingent that landed at Beira and passed through Rhodesia was severely infected in passing through the coast-belt. They, however, do not appear in our returns.

Komati Poort, at the lower end of the Krokodil Valley and on the frontier between the Transvaal and Portuguese East Africa, was the only place in which malarial fever was of serious importance. The position necessitated the presence of a garrison, who suffered severely during the hot season after our occupation. The sanitary conditions were very bad, but by a vigorous anti-malarial campaign, including the prophylactic use of quinine, by improvements in the drainage and by the erection of hut barracks at a considerable height above the town, the prevalence was very greatly diminished.

[1] Clifford Albutt's "System of Medicine."

A hospital ship was maintained in Delagoa Bay, to which cases were sent from the hospitals at Komati Poort and Barberton with the most satisfactory results.

In spite of these measures, which diminished the incidence, the troops who first occupied the zone were saturated with malaria, so much so that their disposal was a matter of some difficulty.

Lieutenant-Colonel N. C. Ferguson, C.M.G., has furnished some notes on malarial fevers as seen by him in the hospital at Waterval Onder. This station is at the foot of the rack railway which led from the last station on the higher veldt, Waterval Boven, and 686 feet below it. A local resident, the hotel-keeper, stated that before 1900 he had not noticed mosquitoes in the vicinity and that no cases of malarial fever had originated there. His local interests may have influenced this observation. But in the beginning of February, 1901, cases of a malignant infection first occurred in men of the Liverpool Regiment who had not served in a malarial country, nor east of Waterval Boven ; further cases occurred during the remainder of the month, and "in March, and still more in April, malarial fever of local origin became so common that it ceased to be specially noticed. It lessened in May, and since June only a few cases have been observed, which were probably recrudescences," that is, an autumn epidemic.

It is rather surprising that practically no development of malaria has been observed along the eastern line, as the carriages which run between Pretoria and Lourenço Marques are infested with mosquitoes brought up from the valley. During the War, special measures were taken to eliminate these mosquitoes. The epidemic of malaria in Natal in 1905 is to be remembered in this connection. There, Anopheles are always present, and there is a limited infection in the persons of the indentured Indians, especially along the coast-belt. But only in that one year has anything of a general prevalence been noted.

Lieutenant-Colonel Ferguson notes the frequency of pernicious symptoms, even in apparently mild and uncomplicated cases. These were usually of the algid type ; hyperpyrexia was only observed twice, in patients of great muscular development. No case of black-water fever was observed, probably because of the short period of exposure to infection.

(6) *Comparison of the War Period with that immediately preceding it.*—Having dealt with those diseases conveniently termed "climatic," before proceeding to consider the "other diseases" in some detail, it is useful to compare the whole incidence of disease during the campaign with some standard, and the most appropriate comparison is with the disease incidence in South Africa during the ten years immediately preceding the War period. This comparison

is presented in the accompanying table, in which some rearrangement of the current classification has been needed, as shown therein.

The main results are as follows:—

(*a*) The total disease incidence during the War was 843 per 1,000, as against 738 in the previous period, or a net increase of 105 per 1,000. This is the resultant of a very great increase in "climatic disease" (252) and a large decrease in all other diseases taken together (147). The increase in the mortality (19) is due entirely to that from enteric fever and dysentery.

(*b*) The net decrease in general diseases, excluding those termed for convenience "climatic," is 126 per 1,000. There is a small decrease in mortality also, 0·62.

This is the resultant of a small increase (70), of which debility contributes more than half, two highly infectious diseases, measles and influenza (which occurred in comparatively widespread but short epidemics) contribute one-fifth, while rheumatism accounts for the remainder, and of a large decrease (196) in the remainder of the group, of which syphilis and gonorrhœa together account for 186. These differences are such as might have been expected under war conditions.

(*c*) Local diseases show a small net decrease (22). Those of the generative system (in which venereal sore has been included on both sides) show a decrease of about one-half. Others which show a decrease are mainly those in which a man anxious to do his duty could go on without much difficulty, *i.e.*, those of the lymphatic system, of connective tissue, and of the skin. The last two results, however, are somewhat surprising.

The local diseases in which an important increase appears are those in which (with one exception) the conditions of field service might be expected to prove effective in increasing prevalence, *i.e.*, diseases of the nervous system, of the circulation, digestion, and of the organs of locomotion. Nervous diseases increased rather more than one-quarter, those of the circulatory system are about doubled, those of the digestive system increased about one-third. Diseases of the respiratory system, on the other hand, show an increase of rather less than one-tenth, and about two-thirds of these admissions were due to catarrhal bronchitis.

(*d*) As regards mortality, in the general diseases, there is no very important difference. The decrease in that from tubercular disease is (if real) probably due to the more rapid invaliding which took place during the War. Mortality from diseases of the respiratory system was more than doubled (almost entirely from pneumonia) and that from diseases of the digestive system increased by about one-half, mainly due to deaths from hepatic abscess and peritonitis.

The general results show that apart from the two epidemic diseases, field service in South Africa is on the whole not less healthy

than garrison life in that country. They also emphasise the necessity for the elimination of epidemic disease.

COMPARATIVE RESULTS—WAR PERIOD AND DECADE, 1888-1897.

Disease	War Period		1888-1897		Increase		Decrease	
	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.
Climatic, less diarrhœa ..	346·73	21·33	94·8	2·19	251·9	19·14	..	..
Other general diseases ..	181·25	0·55	306·7	1·17	..	..	125·5	0·62
Local diseases	314·98	2·68	336·7	1·82	..	0·92	21·7	..
All diseases	843·07	24·58	738·2	5·18	104·9	19·4	..	..

DETAIL, OTHER GENERAL DISEASES.

Disease	War Period		1888-1897		Increase		Decrease	
	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.
Other eruptive fevers ..	3·50	–	1·1	–	2·4	..	..	..
Influenza	20·02	–	8·4	–	11·6	..	..	..
Septic diseases	1·21	0·07	1·7	0·10	..	..	0·5	..
Tubercle	2·89	0·25	3·0	0·63	..	..	0·11	..
Syphilis	19·41	0·01	120·9	0·21	..	..	101·5	..
Gonorrhœa	19·23	–	103·7	–	..	..	84·5	..
Parasitic diseases	7·34	–	12·0	–	..	..	4·7	..
Alcoholism	1·09	0·02	2·5	0·03	..	..	1·4	..
Rheumatism	55·09	0·05	37·5	0·10	17·6	..	..	..
Debility	46·77	0·02	9·5	–	37·3	..	..	..
Other diseases	3·38	0·05	6·4	0·10	..	..	3·0	..

The following diseases which are not represented at all in the period 1888-1897 give a total incidence of 1·3 : Small-pox, plague dengue, diphtheria, Mediterranean fever, scurvy.

DETAIL, LOCAL DISEASES.

Disease	War Period		1888-1897		Increase		Decrease	
	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.	Incid.	Mort.
Nervous	11·49	0·20	9·0	0·42	2·5	..	..	0·22
Eye	11·43	–	13·7	–	..	..	2·3	..
Ear and nose	8·94	0·00	9·8	–	..	..	0·9	..
Circulation	19·67	0·38	9·1	0·32	10·6	..	..	..
Respiration	30·66	1·29	28·1	0·42	2·6	0·87	..	..
(1) Digestion	142·07	0·66	107·7	0·45	34·4	0·21	..	..
Lymphatic	5·05	–	23·8	–	..	..	18·8	..
Urinary	4·13	0·13	2·4	0·18	1·7	..	..	..
(2) Generative	17·15	0·00	35·6	–	..	..	18·4	..
Locomotion	15·18	0·02	11·0	0·03	4·2	..	..	..
Connective tissue	17·18	0·00	30·6	–	..	..	13·4	..
Skin	29·65	–	53·4	–	..	..	23·8	..
No appreciable disease ..	2·38	–	2·5	–	..	..	..	..

NOTES.—(1) Includes diarrhœa in both groups; (2) includes venereal sore in both groups.

The ratios for the War period are "corrected" as before.

0·00 under mortality shows that some deaths occurred, but below 1 per 100,000; a dash, that no deaths occurred.

CHAPTER XIV.

(7) *Individual General Diseases.*

Small-pox.—Cases, 10 ; deaths, none.

Small-pox of the normal type is common in South Africa among the natives, so common that, as already pointed out, its prevention is one of the two objects on which money is spent by the municipalities. There is also a disease prevalent among the native population—*amaas*—which is believed to be a modified small-pox, though opinion is not conclusive on this point.

The infinitesimal incidence in the field army needs no further comment ; it sufficiently indicates the benefits of vaccination.

Eruptive Fevers.—Incidence 3·5 per 1,000.

Measles.—Cases, 1,218 ; deaths, 4.

This disease appeared among the troops (apart from isolated cases) towards the end of 1901. It is said to have been prevalent among the commandoes at the same time. It was comparatively localised in incidence. Lieutenant-Colonel Coutts makes the following remarks :—

"Measles appears to have prevailed among the Boers at various times during the war, and it is well known what havoc it wrought among the women and children in the refugee camps. An epidemic occurred among the Boer prisoners of war at Simon's Town in the early part of 1900, it spread to the crews and guards on board the transports, and attacked a considerable number of the prisoners who were convalescing from enteric fever, and, by setting up broncho-pneumonia, often led to a fatal issue in such cases. The Medical Officer, Dr. Gerard Carré, expresses the opinion that the disease was brought by the prisoners from Cronje's laager, where it was described to him as raging. The report of No. 6 Stationary Hospital at Green Point records the admission there of nineteen cases among the regular troops and ten among the Colonial troops, chiefly from the transports."

Scarlet Fever.—Cases, 338 ; death, 1.

A small epidemic of a mild type occurred in the hot season, 1901-02. The cases were by no means typical, and the diagnosis was perhaps doubtful. There were a few sporadic cases elsewhere :

twenty-four were admitted to No. 7 General Hospital, Pretoria; eleven from the garrison, and thirteen sent in from the district. Lieutenant-Colonel Coutts remarks as follows :—

"A few stray cases of scarlet fever occurred here and there during the war, but the disease nowhere attained epidemic proportions, and was invariably of a benign type. It was probably imported at various times; some cases were admitted at Green Point from the transports, and two cases were treated at Kimberley in the early part of 1900, in men who had brought the disease from Cape Town. Seven cases were treated in No. 6 General Hospital at Naauwport, one of whom developed enteric fever when desquamating."

Plague.—Cases, 24; deaths, 4.

Plague appeared among the natives near King William's Town in November, 1901; and in Cape Town in the following January, among the natives employed at the docks. From them it spread to the native, and later to the European population of Cape Town.

The total cases reported by the Medical Officer of Health, Cape Colony, as *occurring in Cape Colony*, from the beginning of the epidemic to March 1st, 1902, was 877, of which 221 were Europeans, including those among the Imperial forces, 24. In the Cape Peninsula alone, 745 cases occurred, of which 192 were in Europeans, and 20 belonged to the Imperial forces.

The distribution was as follows :—

Green Point Camp	11	(close to the docks, the original focus).
Cape Town	5	
Maitland Camp	4	(close to Cape Town).
Hermon	1	(both of these places were in constant communication
Port Elizabeth	1	with Cape Town).
On board ship	1	(between Cape Town and Durban).
Mafeking	1	(the only case among the troops outside Cape Colony).

The distribution in time was as follows :—

	Cases.		Cases.
March	9	June	2
April	6	October	3
May	3	February	1 (1902)

The preventive measures put in force followed three lines: (1) Cape Town ceased, as far as possible, to be a port of disembarkation of supplies. (2) Green Point Camp was evacuated as far as possible. (3) Movements from Cape Town were limited to what was absolutely necessary, and all troops passing up the line were systematically inspected at special halting places. (See also the Report on the Medical Arrangements in South Africa, p. 69).

The epidemic was, as shown above, mainly confined to the Cape Peninsula, but the immediate control of the supplies and

movements of troops limited the development among the troops almost entirely to Cape Town and its vicinity.

Dengue.—Cases, 335 ; deaths, none.

This, a sudden epidemic, was practically confined to one column operating on the Natal-Zululand coast-belt in the hot season 1901-02.[1] There is, however, reason to believe that a smaller number of unrecognised cases had occurred on the northern border of Natal in the previous hot season, and some cases of a similar type occurred in the Eastern Province of Cape Colony. In all these instances glandular enlargements formed a prominent feature of the disease. The high infectivity and the sudden development of this disease may be a very serious matter in an isolated body of troops, such as the column mentioned, which was suddenly rendered temporarily useless. Protection against the mosquito (*Culex fatigans*) is, under the conditions of field service, a matter of very great difficulty; the only alternative is isolation of the earlier cases.

Influenza.—Incidence, 20·02 per 1,000.

This disease appeared as usual in "slight periodic epidemics," which were never of any importance. The Principal Medical Officer, No. 7 General Hospital, notes that these occurred "generally among men lately arrived in the country," that is, among those who may have introduced infection with them. Major F. Smith calls attention to the further complication in the early diagnosis of enteric fever by any such addition to the ill-defined pyrexias common on service.

Lieutenant-Colonel Coutts makes the following remarks :—

"Influenza is believed to have been introduced at various times during the war at the ports of disembarkation, and to have been carried up country by persons arriving in infected transports, but it seems probable, from an examination of the records, that a great many cases were diagnosed as influenza which were really cases of mild fever not influenzal, and that influenza, with simple continued fever, served to catalogue cases of fever of short duration, which could not be definitely assigned to enteric fever or other acute specific disease. The chief symptoms recorded are sudden invasion, severe headache, and fever of a few days' duration ; but there was a remarkable absence of that sudden and widespread incidence of the disease on whole communities, which has been so often observed, and an equally remarkable absence of catarrh of the naso-pharyngeal and bronchial mucous membranes, and of

[1] For a full account, see Major Beveridge, D.S.O., Journal of the Royal Army Medical Corps, vol. iii., p. 335.

pneumonic sequelæ. The Medical Officer of No. 6 Stationary Hospital, Green Point, records the fact that a certain number of the cases were followed by considerable and persistent debility, which necessitated a change to England; and Dr. Carré states that the disease, together with enteric fever and measles, prevailed in epidemic form among the prisoners of war at Simon's Town, and spread to the guards on board the transports. It attacked men suffering from enteric fever, and thus increased the gravity of the prognosis. He expresses the opinion that it was brought by the prisoners from Paardeberg, but this is doubtful, as it was not observed among them at Modder River, where they remained several days before being despatched by rail.

"The report of No. 19 Stationary Hospital records 370 admissions for influenza, and states that they occurred chiefly between August and November. The disease 'was unlike European influenza, and was not infectious; it was characterised by fever of irregular character lasting from two days to two months; the symptoms were as a rule mild and nondescript in character—headache, neuralgic pains in various parts, depression, and sometimes gastric disturbance. There was no rash, and occasional bronchitic signs the only complication. The blood serum did not give Widal's reaction with Malta fever micrococci, or typhoid or colon bacilli, and it is presumably an unclassified disease peculiar to the country.

"Two hundred and twenty-two cases of influenza were under treatment in No. 10 General Hospital, Bloemfontein, in 1900, 194 being direct admissions and twenty-eight transfers. The registrar of this hospital, Major Freeman, states that the majority of the direct admissions occurred in September and November, 1900, when influenza was epidemic in Bloemfontein. He found a close relationship between the incidence of influenza and rheumatism and sore throat (including tonsillitis) and is inclined to think that some of the cases diagnosed rheumatism, sore throat or tonsillitis, should have been returned influenza. He also notes that influenza was apt to be followed by debility out of all proportion to the severity of the antecedent disease. Thus twenty of the 194 direct admissions were invalided to the base.

"We have only been able to find one case of fatal pneumonia attributed to influenza, and it occurred in No. 3 General Hospital, Kroonstad."

It is of course the case that everywhere influenza is used as a convenient term to indicate a short pyrexia of indefinite nature and uncertain origin. Probably this will always occur. With regard to the relationship between the incidence of influenza, rheumatism, and sore throat noted by Major Freeman, this is well marked in our statistics in this country, but there is nothing to

show that this relation is more than can be accounted for by the laxity in diagnosis of these minor symptom complexes.

Diphtheria.—Cases, 32; deaths, 2.

Diphtheria is relatively common throughout South Africa, not only in the towns, but on the farms, hence a greater number of cases might have been expected. Antitoxin was used where possible, as in the large general hospitals. "At No. 17 Stationary Hospital, Middelburg, two cases of pharyngeal diphtheria occurred as a complication of enteric fever" (Smith).

Mediterranean Fever.—Cases, 35; deaths, none.

One well-marked case occurred in an officer from Modder River, three months after leaving Malta. He may have shown an unusually long incubation period, or the attack may have been a severe relapse after an ephemeral and unnoticed first attack. He made a good recovery.

Through the work of Lieutenant-Colonel C. Birt and of Dr. Strachan, of Philipolis, Orange River Colony, it is now known that Mediterranean fever exists in endemic form in the south-west of the Orange River Colony. In Bloemfontein in 1900, Civil Surgeon Dodgson obtained a positive Widal reaction in several cases. But there is no evidence that the prevalence during the campaign was materially greater than these numbers reveal. During the five years 1903 to 1907, the prevalence in South Africa was only 0·4 per 1,000.

Septic Diseases.—Incidence, 1·21; mortality, 0·07 per 1,000.

	Cases.	Deaths.
Erysipelas	496	12
Pyæmia	19	9
Septicæmia	18	6
Tetanus	6	3

These figures speak for themselves.

Tubercular Diseases.—Incidence, 2·89; mortality, 0·25 per 1,000.

	Cases.	Deaths.
Tubercle of lung	1,088	87
Other forms	194	23

Three points may be noted here, first, that although all the men had been examined for active service, yet it is known from personal experience that some men (of the Reserve) had been sent out though suffering from (and in one case under treatment in hospital) tubercular disease, "for the benefit of their health." Further the usual examination for fitness for active service is rarely carried out under such conditions as to permit of the detection of early cases without obvious signs, where, too, no assistance is to be obtained from the man in the matter of a history. Next, since the war, a few cases, officers and men, have occurred of invalids in whom the disease appears to have first become evident during the

campaign, if the evidence is indeed not strong enough in every case to show that it was actually contracted at that time. Lastly, as already mentioned, the mortality was probably affected by the rapid invaliding of all cases.

"The influence of an open-air life in a dry climate even under the strain of severe conditions is nowhere more eloquently set out than in the medical report of the war" (Smith).

Lieutenant-Colonel W. J. MacNamara notes that many of the men in the Irregular Corps (South African Colonials) had originally come to South Africa for the benefit of their health, and that most of the cases were chronic in character.

Diseases due to Animal Parasites.—Incidence 7·34 per 1,000.

The only disease of this class which requires mention is that due to *Bilharzia hæmatobia.* Its importance lies, not in the number of cases which occurred during the campaign itself, but in the later evidence of infection shown by the numbers who have received temporary pensions on account of partial disablement from this disease. Major Erskine notes as regards Natal: "Very few soldiers subject to this disease came under treatment, and those who did came from the Newcastle district." In three years in Maritzburg only two cases are noted as having been possibly due to bilharzial infection. Major Smith reports as follows:—

"In ordinary times soldiers serving in South Africa were little subject to the disease, and it seems to have been of very minor importance as a cause of ill-health in former campaigns in that country. The Army Medical Department Reports for the period 1890 to 1898, when the garrison had an average annual strength of 4,164, make no mention of bilharzia, the nearest approach to it being eight cases of hæmaturia returned during the period; while the reports dealing with the sick statistics of the Zulu and first Boer Wars contain no reference to it.

"Bilharzia has long been known to be endemic in the Eastern Province of Cape Colony, in Natal, and in certain parts of the Transvaal. Its existence in the older colonies was brought to notice by Dr. John Harley in 1864, and by Staff Assistant Surgeon Batho, in the Army Medical Department Report for 1870. Dr. Batho reported that in Natal the disease was very common in boys, and that the colonists, who were familiar with it as boys at school, did not attach any importance to it.

"The Rustenburg district of the Transvaal was also known as a focus of the disease, and a year after the war the well-known war correspondent, Mr. E. T. Knight, spoke of its ravages among the civil population of that district.

"As regards its occurrence among the troops during the war, their constant movements, and their frequent transfer from one

district to another, as well as our ignorance of the duration of the period of incubation, make it difficult to locate the places where the infection was acquired. That the disease occupied a considerable time in the development of its characteristic symptoms was indicated by the small number of cases that came under notice during the war. Notwithstanding these conditions the clinical histories of some of the cases afforded almost conclusive evidence of the existence of the disease in several new localities; the Kroonstad district, the valley of the Vaal River, and the Bush Veld country lying between Pretoria and Pietersburg.

"The Medical Officer in charge of No. 22 Stationary Hospital, Pietersburg, records the admission of three men of the Gordon Highlanders in the latter part of July, 1901, and one in August, for the disease. That regiment had been in the same district from the end of 1900, and of the cases mentioned one man gave a history of hæmaturia lasting for two months, two for four months, and one for five days. One of these first noticed blood in his urine, when on the march from Pienaar's River to Pietersburg, and it is probable that the disease was contracted at the former place. The man's regiment had been encamped for some months at Pienaar's River, a place 40 miles north of Pretoria."

The actual number admitted to hospital during the campaign was 187, but there is some reason to believe that the slighter cases either passed entirely without notice, or were so trivial that although recognised by the sufferer, no attention was paid to the disorder. All the cases that have come under notice appear to belong to the first or second degree, that is, in the milder cases, there were no symptoms beyond the passage of a little blood at the end of micturition and some slight pain at the end of the penis, with occasional pain in the back; all these symptoms were aggravated by exertion, especially by riding. In the more severe cases all these symptoms were present in a higher degree of development, the amount of blood passed was relatively considerable, pain in the back and loins, radiating from there to the perineum, was constant and sufficient to cause discomfort. There was said to be anæmia, but in the cases of men on temporary pension (admitted to Queen Alexandra's Military Hospital at Millbank for observation) only a slight secondary anæmia was present. Similarly the alleged loss of weight did not take place while the patient was in hospital and properly fed. The trivial anæmia and loss of weight do not appear to be integral parts of the disease even in these cases; they are indirect effects. The sufferer is so far incapacitated, or feels himself to be incapacitated, for work that he is unable to continue in his employment, if he has obtained work, and these symptoms are in reality the result of

underfeeding, not of the disease. The patients still in the Service, who came under observation, did not show either of these symptoms, even where the discharge of blood was considerable.

Cases of the third degree, that is, with secondary changes involving the bladder and other parts of the urinary tract, have not come under observation. The reason probably is that in all our cases the infection has been slight, exposure ceased when the case left the infected area in South Africa, and the number of parasites was thus limited.

Our records, however, show that even in the mild type of case which is most prevalent, a permanent cure is long delayed. The men come up for examination every six months, and it is usual to find the urine free from blood, albumin, or ova at one examination, and to find a recurrence at the next examination, or even after freedom on two consecutive examinations at six months' interval, to find a recurrence at the third. This points to an intermittence of the discharge of ova, and therefore to a decrease in their production, *i.e.*, a tendency to recovery, but absolute freedom appears to be long delayed.

The result of this persistent infection is in nearly all cases practically negligible, that is, the sufferer is able to work if he is not incapacitated by some other disability or by disinclination.

Treatment has been without any effect whatever. One patient in Millbank, born and bred in Natal, stated that the Zulus were in the habit of using sea-water internally and by injection as a mode of cure. Salt by the mouth and rectum had, however, no effect on this case. Rectal infections have been very rare.

Nothing bearing on the mode of infection was observed during the campaign; the usual alleged sources were of course existent.

"The prevention of the disease is a matter on which it appears desirable that some rules should be laid down. Urine, and probably fæces, should be destroyed; and latterly this has, we understand, been done as far as patients in hospital are concerned. It is obvious, however, that these measures are of little use unless the patient can be persuaded to continue to disinfect his excretions after leaving hospital. It is not likely that many of the afflicted would keep up such preventive measures very long" (Smith).

Scurvy.—Cases, 152; deaths, 11.

At no time was there any prevalence of this disease, or even of a scorbutic tendency, although from time to time it was alleged that in certain localities some of the troops suffered from spongy and bleeding gums. Chronic inflammation of the gums with suppuration in the alveoli was so common that the confusion is quite possible. Jam formed a part of the ration, and during a great part of the campaign an issue of apricots or peaches was made, while vegetables were also issued.

As regards Ladysmith, Major Erskine reports as follows :—

"This disease only came under notice in the Natal army among the troops forming the garrison of the beleaguered town of Ladysmith, for Natal is a fruit-growing country where pineapples, other fruit and vegetables of all kinds are plentiful. As the siege progressed the scorbutic dyscrasia became evident in cases of obstinate dysentery of a peculiar kind. By-and-by certain cases cropped up indicative of land scurvy. The depressing conditions under which the men were serving and the damp and cold were strong predisposing causes; but the deprivation of fresh vegetable food in their daily rations was the determining factor. The rations served out during the latter part of the siege—from the middle of January till the relief on March 1st—consisted only of three small biscuits and a pound and a quarter of horse or mule flesh.

"*Symptoms.*—The only symptoms and signs presented by the cases detected in the town were malaise with wandering pains in the limbs, and fair-sized brawny patches of discoloration on the thighs and legs. The gum condition was not well marked, if at all.

"On the other hand, among the convalescents and sick at the hospital on the neutral ground of Intombi, 4 miles away, cases occurred having all the classical signs and symptoms in a more or less aggravated form.

"*Treatment.*—Cases which developed and were treated in the town were soon cured, as at the time the disease made its appearance the gardens of the private houses had begun to yield their seasonal supply of apricots. With the administration of these the malady disappeared so far as the garrison proper was concerned, only one death occurring in which hypostatic congestion of the lungs was the immediate cause."

Rheumatism.—Incidence, 55·09; mortality, 0·05 per 1,000.

Rheumatic fever is not common in South Africa, nor are acute articular affections frequent. The great liability to chill from the sudden variations in temperature (as in Natal, where the temperature may fall 20 degrees in a few hours) tends to increase the prevalence of muscular forms of rheumatism. But, speaking generally, the effects of exposure are less than might be expected.

Major Smith writes :—

"*Rheumatic fever* was rare in spite of the hardships of campaigning.

"*Muscular rheumatism*, though fairly common, was by no means so frequent as might have been expected in a long campaign with many old soldiers in the ranks. In the Pretoria hospitals there were close on 2,000 of these cases. They are mostly attributed to hard work and wettings. The Principal Medical Officer of No. 19 thinks a large number were due to constitutional syphilis. He found iodide of potassium the best treatment."

Major Erskine reports from Natal :—

"*Myalgia.*—This was quite a common affection. The muscles affected were usually those which the patient lay and slept on, and the cause was the hard, damp ground he had to use as a bed. In another class of cases, the pain in the soft parts was due to the continued pressure of accoutrements. This pain was severe on movement or palpation. The external muscles of the thigh, arm, and shoulder, also the abdominal and pectoral muscles, were most frequently affected.

"*Rheumatism.*—This was seldom arthritic, nearly always muscular. It was met with in the familiar forms of lumbago, pleurodynia, and at times stiff neck."

Debility.—Incidence, 46·77 ; mortality, 0·02 per 1,000.

Debility is a misleading term which should not be used. It is most usually employed to denote the after-effects of an acute disease, *e.g.*, enteric fever, dysentery, or malaria, especially where a readmission has taken place. This practice, however, renders our statistics less valuable than they might be. It is also used where, for one reason or another, no diagnosis has been arrived at, and one has seen such well-defined pathological entities as chronic nephritis, diabetes, and even thoracic aneurism returned under this head, though in the last case the documents showed that the actual pathological condition had been recognised. For this reason, the class "debility" must always be looked on with suspicion—its true content can never be determined.

But in South Africa, besides the cases falling under one or other of types mentioned above, there was a considerable number of men, free from obvious disease, but worn out by the fatigues of the campaign—men probably of lesser stamina than their fellows, who required only a few days' rest and good feeding to set them up again. These were legitimately included under this heading.

CHAPTER XV.

(8) *Local Diseases :—*

Diseases of the Nervous System.—Incidence, 11·49; mortality, 0·20 per 1,000.

Compared with the period 1888-97, the distribution is as follows :—

Mental disease ..	War period ..	Incidence, 1·76	Mortality, 0·03
	1888-97 ..	1·00	0·05
Other forms ..	War period ..	9·74	0·18
	1888-97 ..	8·00	0·37

There is no great difference between these results.

The following table shows the number of cases and the corrected ratios per 1,000 for officers and men of all classes for certain forms of nervous disease :—

Officers.

Disease	Regulars and Volunteers		Imperial Yeomanry		Colonials		Total	
	Cases	Ratio	Cases	Ratio	Cases	Ratio	Cases	Ratio
Mental ..	11	0·95	3	2·42	5	1·32	19	1·14
Neurasthenia	44	3·80	4	3·23	–	–	48	2·89
Epilepsy ..	7	0·60	7	5·65	–	–	14	0·84
Other forms ..	104	8·97	10	8·07	31	8·20	145	8·73
Total ..	166	14·35 ±0·69	24	19·36 ±2·41	36	9·52 ±0·98	226	13·61 ±0·63
Other Ranks.								
Mental ..	640	1·90	28	1·13	113	1·39	781	1·76
Neurasthenia	125	0·37	12	0·48	22	0·27	159	0·36
Epilepsy ..	835	2·47	77	3·11	125	1·54	1,037	2·33
Other forms ..	2,429	7·20	256	10·35	446	5·49	3,131	7·05
Total ..	4,029	11·94 ±0·11	373	15·08 ±0·83	706	8·70 ±0·19	5,108	11·50 ±0·10

The gross incidence among the officers is seen to be always greater than among the men, but from the consideration of the probable differences, this is only significant among the Regulars and Volunteers; among the Imperial Yeomanry and Colonials the differences are not legitimately distinguishable on the numbers given. This greater incidence among the officers rather than the men of the

Regulars and Volunteers is mainly due to a higher admission-rate for neurasthenia, and it is possible that the distinction is purely artificial, and that similar cases among the men were returned under the headings of "debility" or "disordered action of the heart."

The greater frequency of epilepsy among the Imperial Yeomanry may be noted; this, however, may be only accidental.

Comparing the different classes of officers, the ratios in the Regulars and Volunteers and Imperial Yeomanry are not distinguishable; on the other hand, Colonial officers showed a distinctly smaller incidence than the Regulars and Volunteers, and *ipso fortiori* than the Imperial Yeomanry. The men of the Colonial troops showed a distinctly smaller incidence than those of the Regulars and Volunteers, and those again than the Imperial Yeomanry; the chief cause of this difference was in both cases in the diseases termed "other forms" in the above table.

It is difficult to account for these differences. The two agents most universally invoked in relation to the origin of nervous disease, syphilis and alcohol, were for the most part non-effective during the campaign; their influence, however, would hardly develop during the comparatively short period of observation, and such influence as they exercised must have been chiefly before the beginning of the war. On the other hand, the distribution of these diseases among the different classes is not quite in accordance with accepted ideas as to the prevalence of alcoholism and syphilis in the same classes. Generally speaking, it seems as if the lesser prevalence was associated with the habit of physical labour and acquired ability to withstand fatigue.

One important point is that the recorded incidence does not represent the whole effect of the campaign in the production of nervous disease, especially of a functional type. It is impossible to obtain the number of cases due to, but coming on record after the campaign; there is, however, no doubt that a large number of individuals suffered, either immediately after the cessation of operations or at a later period, from various disorders, usually of a neurasthenic type, but many on the border line of mental disease or of other organic disease of the nervous system. It happens that the cases which have come directly under observation have been almost entirely among officers, but there is reason to believe that the results among the other ranks have also been well marked.

Even allowing for this unknown increment, the total incidence of nervous disease of all types is by no means as great as one might have expected. As has been stated above, two important factors were practically absent; apart from epidemic disease, the general conditions were, as has been shown, by no means inconsistent with perfect bodily health.

Fatigue and exposure were at times excessive, but the men, though without superfluous flesh, were in splendid condition, and never better than in the last year of the war. There were, on the other side, the special conditions of war, the almost constant strain of watchfulness, the intermittent excitement of action, and, for the officer, the never-ending work and anxiety to carry on without a hitch.

Modern developments in the art of war and in the organisation of armies demand, it is said, a higher degree of intelligence in all ranks than has hitherto been found to be sufficient. The special form of intelligence that is most likely to be useful in warfare is that in which the imagination is highly developed, that intelligence which sees what is on the other side of the hill. It is this type, however, that is most exposed to the risk of the development of functional nervous disorders under unfavourable conditions, and, if it become predominant, we must look for a greater prevalence of nervous breakdown than we have as yet experienced. The fact that a proportion of officers holding highly responsible positions broke down from the nervous strain was more or less explicitly recognised during the campaign; as regards the field army, it was not uncommon to hear that so-and-so had "lost his nerve," and sometimes another sphere of usefulness was found for the individual concerned. The same thing was to be observed in those whose duties brought them less prominently before the army generally. A careful examination of the history of the war points to the same conclusion, that of these superior intelligences it is only the exceptional man who can maintain his average standard of work for any length of time under such conditions as obtained in South Africa; some of these conditions were certainly not an essential part of the operations of war. An unknown American philosopher once remarked: "Damn your brains, give me a reliable set of bowels," and this expresses shortly the quality which is most likely to lead to efficiency in the long run. There is no doubt but that superiority in intelligence may be purchased too highly; name and reputation will at the beginning of the breakdown carry through inferior work, and it is, unfortunately, at this stage that the individual concerned is more than ever convinced that he alone can get things done.[1] It is obviously a difficult task to remove such men when their work becomes untrustworthy and therefore dangerous. The greater part of the work of an army, as the greater part of the work of the world, can best be carried out by men of good health, average intelligence, and sound common-sense. These qualities are, fortunately, charac-

[1] Perhaps the most striking example of this is to be found in the Comte de Ségur's account of the Moskow campaign.

teristic of the great majority of our officers and men. It only remains to ensure that they shall not only be allowed but required to make use of their abilities. The small leaven of genius which is needed for success must be carefully preserved for the work which can only be done by those fortunate enough to possess it.

Major Smith makes the following note:—

"*Paralysis* furnished fourteen cases at No. 2 General Hospital. Among them were some paraplegias due to myelitis coming on after exposure to wet and cold, and others following bad malaria. One of us (F. S.) describes a couple of cases which he met with on the march. The subjects were young, healthy-looking men, and good soldiers, who seemed perfectly willing to do their best, but were powerless on account of the weakness of their legs. After a day's rest they seemed all right, but before they had walked far their legs trembled, and they soon sat down—for a time again helpless. The condition seemed similar to that temporarily experienced sometimes by most of us when we subject a hand or arm to severe and prolonged exertion of an unusual kind, *e.g.*, pulling in a boat race without previous training. Presumably, the state was brought about in the two soldiers by long and repeated marching."

Diseases of the Eye.—Incidence 11·43 per 1,000 as compared with 13·7 during the previous decade. Nearly half the cases (2,363) were due to catarrhal conjunctivitis, no doubt the result of the dust. Granular conjunctivitis caused only sixteen admissions, interesting in view of the fact that some twenty years before the war an infective conjunctivitis was exceedingly prevalent among the troops then stationed in the Eastern Province of Cape Colony.

The only important cause of inefficiency was ametropia, 859 cases. Most of these were cases of hypermetropia in whom the persistent strain of examining a distant horizon had broken down their accommodation, and the individuals found themselves quite unable to shoot. It does not seem advisable to facilitate the enlistment of hypermetropes: they may remain efficient during their Colour service, but many break down when recalled to service from the reserve.

Diseases of the Ear and Nose.—Incidence 8·94 per 1,000, practically the same as in the previous decade (9·8). About one-third were on account of inflammation of the external meatus: another third were from inflammation of the middle ear (with three deaths), while the rest were from various causes.

Diseases of the Circulatory System.—Incidence 19·67, mortality 0·38 per 1,000, as against 9·1 and 0·32 respectively in the previous decade. The incidence is then rather more than doubled, and the mortality about the same, subject (as in the case of tubercular disease) to the condition that it may have been relatively diminished

by the more rapid invaliding during the campaign, and indeed by the short period of observation.

The distribution of cases and deaths, and the incidence-rates among the various groups are subjoined. Practically the whole of the mortality resulted from valvular disease of the heart, other diseases of the heart and pericardium (pericarditis and endocarditis) and from aneurism, and occurred among the Regulars and Volunteers and the Colonials. There is for all practical purposes no difference between the mortalities among the warrant and non-commissioned officers and men of the different groups.

DISEASES OF THE CIRCULATORY SYSTEM.

Officers.

	Regulars and Volunteers			Imperial Yeomanry			Colonials			Total		
	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio
Valvular disease of heart	20	1	1·73	2	–	1·61	5	1	1·32	27	2	1·63
Other diseases of heart, &c.	7	1	0·61	1	–	0·80	3	—	0·79	11	1	0·66
Disordered action of the heart	19	–	1·64	4	–	3·23	5	—	1·32	28	—	1·69
Aneurism	1	–	0·08	–	–	—	1	—	0·26	2	—	0·12
Varix	16	–	1·38	–	–	—	3	—	0·79	19	—	1·14
Other diseases of vessels	24	1	2·07	–	–	—	6	1	1·59	30	2	1·81
Total	87	3	7·52 ±0·50	7	–	5·64 ±1·28	23	2	6·08 ±0·78	117	5	7·05 ±0·40
Men.												
Valvular disease of heart	2,140	59	6·34	227	3	9·18	246	13	3·03	2,613	75	5·88
Other diseases of heart, &c.	225	37	0·67	7	1	0·28	33	10	0·41	265	48	0·60
Disordered action of the heart	3,208	3	9·51	206	—	8·33	217	—	2·67	3,631	3	8·17
Aneurism	95	31	0·28	5	—	0·20	10	3	0·13	110	34	0·25
Varix	1,419	1	4·20	128	—	5·17	227	—	2·80	1,774	1	3·99
Other diseases of vessels	258	5	0·76	36	1	1·45	53	—	0·65	347	6	0·78
Total	7,345	136	21·77 ±0·15	609	5	24·62 ±0·60	786	26	9·68 ±0·21	8,740	*167	19·67 ±0·12
Mortality ..	0·40 ± 0·02			0·20 ± 0·05			0·32 ± 0·03			0·38 ± 0·01		

* 36 of these deaths occurred out of hospital.

The incidence among the officers is seen to be invariably much less than among other ranks (but see later). In the Regulars and Volunteers it amounts to less than one-half: in the Imperial Yeomanry to probably less than one-fourth: in the Colonials to about two-thirds. Here again the greater similarity between

officers and men than in the other groups may be observed, probably because here the social distinctions and all that these connote were less well marked.

The incidence-rates in order of magnitude are as follows :—

Men	Imperial Yeomanry	24·62	Each of these is quite distinct from that succeeding it.
	Regulars and Volunteers ..	21·77	
	Colonials	9·68	
Officers	Regulars and Volunteers ..	7·52	These rates are indistinguishable.
	Colonials	6·08	
	Imperial Yeomanry	5·64	

From time to time, considerable stress has been laid on the importance in the production of diseases of the heart of our methods of training the soldier. It may be well, then, to call attention to the fact that the incidence among the Imperial Yeomanry (who received no training of the type to which the Regular soldier is subjected) exceeded that among the Regulars and Volunteers. This is additional evidence that the soldier's training is at the worst only a subsidiary element in the production of these diseases.

Comparing the total incidence of all types of disease as between officers and men, there is a total difference of 12·62 per 1,000 made up as follows :—

Increase among the men in :—

Valvular disease of the heart	4·25	13·59
Disordered action of the heart	6·48	
Varix	2·86	

Decrease among the men in :—

Other diseases of the vessels	1·03

That is to say, valvular disease of the heart accounts for 31 per cent. of the increase, disordered action for 47 per cent., and varix for 21 per cent.

The incidence and mortality for these diseases may be compared with that in South Africa during two periods of five years—in the first some troops were in the field in every year of the period, while 1879-80-81 formed a war period. In the second, no troops were in the field except the few in Matabeleland and Mashonaland.

War Period, 1899-1902. Regulars and Volunteers Only.

Incidence 21·77 ; Mortality, 0·40 per 1,000.

1878	Incidence	17·8	Mortality 1·42	As regards the mortalities, the number of deaths is always small, and the ratios must, therefore, not be compared too closely.
1879		22·4	0·88	
1880		20·9	1·44	
1881		15·5	0·19	
1882		12·2	0·51	
1894		5·7	0·32	
1895		13·5	0·86	
1896		5·7	0·23	
1897		6·3	0·14	
1898		7·9	1·08	

Practically the incidence during the South African War was the same as that during the war period 1879-80, while the mortality was almost certainly less. During the last five years before the war, the incidence-rate was distinctly less.

Valvular disease of the heart (5·88 per 1,000) is the most important item in the table, though not the largest numerically. Of the 2,613 admissions, 75 died (including 9 out of hospital) and 1,895 (72·6 per cent.) were invalided, while 643 (24·6 per cent.) returned to duty.

Valvular disease in the soldier is, speaking generally, not so serious an affection as in civil life ; it is more often a pathological condition of the valves, revealed by abnormalities in the sounds, than a true disease of the heart as the principal organ of the circulation. There is little doubt that many men invalided from the Service on this account would now be accepted by most insurance companies without demur, so that the incidence in the Army is artificially exaggerated as compared with that among civilians. There are, however, several factors which tend to make the diagnosis of heart disease (and of consequent unfitness for service) more dogmatic than would be the case under different circumstances. The most important of these is the doubt whether a heart which is to some extent abnormal will stand the strain of active service. Those who look upon this uncertainty as to the progress of the case as *the* important element are probably justified by the figures given above, which show that incidence in war is about double that in peace, even where those obviously unfit have been eliminated. This view is generally held throughout the Army, and as the soldier comes up for medical examination at comparatively frequent intervals, his fate is most usually determined on these lines.

There is, of course, an important difference between the soldier and the civilian, which necessitates a different method of dealing with doubtful cases such as this. As regards the civilian, the prognosis of his condition is essentially one which concerns him alone. On the other hand, the soldier, unless he is fit for war, has no excuse for existence ; the unavoidable wastage among previously healthy men is often so great as to hamper the operations of an army in the field, and our efforts are now more especially directed to diminishing this loss. We cannot retain men with the Colours who will in all probability break down. So long as we maintain a comparatively small army by voluntary enlistment we must ensure, as far as we can, that every member of it is, without reasonable doubt, fit for any duty that may be required of him.

It is sometimes said that these cases should be retained with the Colours because they have broken down in the Service, and that their discharge by invaliding has a bad effect on recruiting,

and generally shows a want of sympathy with a most deserving class of men. But the efficiency of an army for war is not a subject which lends itself to philanthropic treatment; the two things, efficiency, and the care of those who have broken down in the Service, must be kept absolutely distinct.

Disordered action of the heart showed a relatively heavy incidence among the men (8·17). The Regulars and Volunteers and the Imperial Yeomanry were alike in this respect. Of 3,631 cases admitted, 3 died; 1,470 were invalided (41 per cent.) and 2,158 (59·5 per cent.) returned to duty. As the last proportion is so high, the total probably includes many duplicate, or even triplicate, admissions, so that the actual incidence was probably less than that shown.

Etiology.—The most fruitful cause of heart disease (acute rheumatism) was not of great importance, and cannot have formed an important element in causation. Some of the deaths from endocarditis and pericarditis were in all probability due to this cause.

Three factors undoubtedly contributed to the increased prevalence:—

(*a*) During the war the examination of recruits on enlistment was less stringent than it was either before or after. The proportion of all recruits presenting themselves for enlistment, who were rejected on account of disease of the heart, was during 1899-1900 less than in the preceding or succeeding years. Over the period 1889-1908 there existed a distinct, though small, inverse relationship between the numbers so rejected and the admissions for diseases of the heart in the United Kingdom. This laxity in examination accounts for some, probably a small part, of the increase.

(*b*) The unavoidable mental and physical strain of the campaign affected both officers and men, of which the former probably told more on the officer and the latter on the man. Mental and physical work under stress is without doubt an element in producing increased blood-pressure, with the usual results. The actual demands on the bodily strength of the men were at times very great and heavier than on the officers, though as most officers carried a rifle or carbine, there was less difference in this respect than is usual.

(*c*) The general malnutrition. The field-ration was good and ample. But the very general prevalence of dental caries, the loss of teeth, and the associated oral sepsis, made it impossible for many of the men to chew the bully beef and biscuit, or to digest the lumpy mass which they swallowed. The officers were better off in this respect; their teeth were, as a rule, in better condition, and they had more opportunity of adding to the ration than the men.

These three factors do not, of course, hold that predominant position in peace that they assume during war. As regards *disordered action of the heart*, observations carried out at Millbank and at the Royal Herbert Hospital show that in the young soldier disordered action of the heart, pure and simple, is not a common condition.[1] Many so-called cases are, in fact, consecutive to digestive troubles, and these were probably numerous during the campaign, for reasons given above. In most cases, however, the cardiac symptoms are associated with a general condition of increased irritability of the skeletal muscles and of the vasomotor system, associated also with a very variable pulse-rate, and a relatively high blood-pressure (about 140 mm.), both of which are affected by bodily or mental exertion, but where the actual effect of these stimuli cannot be foretold; they may be followed by an increase or decrease in either pulse-rate, or pressure, or both. The following extract from the report by Major Smith, D.S.O., agrees with the experience gained in the observations mentioned above :—

"Some of the patients were very bad; their nervous system generally seemed out of order, and they could not stand long in one position without shaking all over. The Principal Medical Officer, No. 2 General Hospital, says that there were several varieties of pulse, simple increased frequency, the same with irregularity or intermittence. In some patients the affection was constant, though always increased by exertion, others were all right when at rest."

It has been shown that functional nervous affections were more prominent among the officers than among the men. It is likely that this accounts to some extent for the difference in the opposite direction in the case of disordered action of the heart. Both conditions appear to be alike in origin, a failure (probably congenital) of the normal process of repair, a local malnutrition, of which the symptoms were perhaps more obviously of the general nervous system among the officers, and of the cardio-vascular system among the men, for the whole experience of the incidence of disease (other than epidemic) in war shows that it is those systems of the body which are especially overworked that break down.

Aneurism.—Taking into account the large number of older men, reservists and others, especially in the South African Colonials, aneurism was comparatively rare. One may note in this connection that, although the work was heavy, the clothing of the men was loose, and the way it was worn diminished constriction of the chest and at the root of the neck. *Varix* is the only other disease

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[1] See JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, December, 1910, p. 712, *et seq.*

demanding special mention. The prevalence was not greater among the Regulars and Volunteers (mostly infantry) than among the Imperial Yeomanry (entirely mounted).

The Effect of Altitude.—The field of operations was for the most part between 4,000 and 5,000 feet above sea-level, and the atmosphere was for the greater part of the year intensely stimulating. It was the custom of the inhabitants of Johannesburg and Pretoria to blame these two conditions for the production of nervous disturbances of these two types, which were comparatively common. It is impossible to differentiate between the effects of these conditions and those due to the general mode of life, where business was carried on at high pressure, and stimulants, tea, coffee and alcohol, were used to excess, the first two indeed were as harmful as the last. But apart from this, it is probable that the general effect of the climate induced (as in the case of the Swiss winter resorts) weaker brethren to more excessive exertion than they were, in fact, capable of undertaking, and in this way influenced the production of these disorders.

Diseases of the Respiratory System.—Incidence 30·66, mortality 1·29, as against 28·1 and 0·42 respectively in the previous decade. Of the deaths, 81 per cent. were due to pneumonia, 6 per cent. to phthisis, 4 per cent. to pleurisy. The total deaths from phthisis were thirty-five, and of these the Colonial troops contributed the unduly large number of twelve, as against nineteen in the Regulars and Volunteers of about four times their strength. This was probably due to the enlistment of old cases in the South African Colonials, and the point was noted in the reports from at least one general hospital.

The distribution of the cases is as follows :—

DISEASES OF THE RESPIRATORY SYSTEM.

Officers.

Disease	Regulars and Volunteers			Imperial Yeomanry			Colonial			Total		
	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio
Bronchitis catarrh	107	..	–	16	..	–	43	..	–	166	..	–
Pneumonia ..	38	6	3·28	3	..	2·42	10	2	2·65	51	8	3·07
Phthisis	8	..	–	1	1	–	5	2	–	14	3	–
Pleurisy	30	1	–	3	..	–	8	..	–	41	1	–
Other diseases ..	49	2	–	6	1	–	15	..	–	70	3	–
Total	232	9	20·05 ±0·29	29	2	23·41 ±7·42	81	4	21·43 ±1·46	342	15	20·60 ±0·69

Men.

Disease	Regulars and Volunteers			Imperial Yeomanry			Colonials			Total		
	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio
Bronchitis catarrh	6,039	15	17·89	408	..	16 50	1,640	7	20·19	8,087	22	18·20
Pneumonia ..	2,089	378	6·19	113	15	4·56	389	71	4·79	2,591	464	5·83
Phthisis	286	19	0·85	35	4	1·42	100	12	1·23	421	35	0·98
Pleurisy	1,121	19	3·25	82	2	3·31	212	..	2·60	1,415	21	3·18
Other diseases ..	793	21	2·35	71	3	2·87	240	6	2·96	1,104	30	2·48
Total	10,328	452	30·61 ±0·18	709	24	28·66 ±0 64	2,581	96	31·79 ±0·37	13,618	572	30·67 ±0·16

The following is the series in order of magnitude :—

Men	Colonials	31·79
	Regulars and Volunteers	30·61
	Imperial Yeomanry	28·66
Officers	Imperial Yeomanry	23·41
	Colonials	21·43
	Regulars and Volunteers	20·05

The Colonial troops head the list on account of a greater prevalence of catarrhal bronchitis. But there is no very striking difference except perhaps the lesser incidence of phthisis among the Regulars and Volunteers.

From its fatality, pneumonia is the most interesting item. Of 2,591 cases among the Warrant and N.C.O.'s and men, 464 died in hospital, giving a case mortality over all of 17·10 per cent. There are no essential differences in the case-mortality among the officers and men, or among the various groups, all approximate to this proportion.

Little more need be said of these diseases. Major Erskine points out (and see below) that the inhalation of dust-laden air was a frequent cause of bronchitis. Major Smith says :—

"Diseases of the respiratory system were most common during the colder part of the year. The Medical Officer of No. 17 General Hospital attributes this partly to the extreme variations between the day and night temperatures (60° F. in the daytime, and 17° F. at night), and partly to the quantity of dust at this season of the year, which causes irritation of the air passages.

"However brought about, pneumonia—to take the most important of these diseases—showed a marked increase in its incidence during the cold season. It occurred sporadically in all parts of the country, and an examination of the recorded cases shows that 73 per cent. were admitted during the colder six months of the year, and exactly one-half during the three months of greatest cold, viz., June, July and August.

"An examination of the clinical and pathological records

appears to show that a considerable proportion of the cases diagnosed as pneumonia were not pure croupous pneumonia. The available records show that the right lung was the seat of the lesion in 40·59 per cent., and the left in 27·53 per cent.; while both lungs were involved in 31·53 per cent. The large majority of the double pneumonias were basal in character, and their unusual number, in comparison with cases in which only one lung was the seat of the disease, is probably to be accounted for by the inclusion in this group of many secondary pneumonias, dependent on various specific diseases."

Diseases of the Digestive System.—Incidence 142·07, mortality 0·66 per 1,000 as against 107·7 and 0·45 respectively during the previous decade. This heterogeneous group of diseases always contributes largely to the list of admissions, at home or abroad, in peace or war. It is characterised by a very great difference between prevalence and fatality; two diseases included in great part belong to the group of climatic diseases, *i.e.*, hepatic abscess and inflammation of the liver. The easiest way to show the difference in prevalence and fatality is to place the percentage of the total admissions and deaths in parallel columns, as below :—

Caries of teeth, &c.	Admissions per cent.	11·0	Deaths per cent.	—
Sore throat and Tonsillitis	,,	17·5	,,	0·7
Gastritis and Dyspepsia	,,	9·5	,,	3·5
Hernia	,,	4·0	,,	0·7
Diarrhœa	,,	29·8	,,	7·0
Jaundice	,,	9·8	,,	0·7
Constipation and Colic	,,	4·2	,,	—
Enteritis, Typhlitis, Colitis	,,	2·7	,,	15·7
Peritonitis	,,	0·2	,,	19·2
Diseases of liver	,,	2·5	,,	43 2
Other diseases	,,	8·8	,,	9·3

The diseases shown above the line account for 86 per cent. of the admissions, but for only 13 per cent. of the deaths.

The diseases of numerical importance have been shown by groups in the table below, and the following particulars are added concerning those of less frequency :—

Officers—					
Diseases of the liver.	Inflammation	Cases	78	Deaths	1
	Abscess		7		6
	Acute yellow atrophy		1		1
"Other diseases."	Enteritis: typhlitis: colitis		229		2
	Peritonitis		8		3
	Unclassified		192		2

Men—			
Diseases of the liver (see p. 170)	Inflammation	724	17
	Abscess	184	97
	Congestion	612	1
	Acute yellow atrophy	6	5
	Inflammation of gall-bladder	64	1
"Other diseases."	Enteritis: typhlitis: colitis	1,738	45
	Peritonitis	104	55
	Unclassified	5,622	27

The only point to note is the extraordinary fatality of hepatic abscess among the officers; it suggests delay in diagnosis, but the explanation may be that the cases were returned under the heading of the primary disease, dysentery.

The following table gives the distribution by groups :—

DISEASES OF THE DIGESTIVE SYSTEM.

Officers.

	Regulars and Volunteers			Imperial Yeomanry			Colonials			Total		
	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio	Cases	D.	Ratio
Caries of teeth, &c.	85	..	7·35	14	..	11·30	13	..	3·44	112	..	6·74
Sore throat and tonsillitis	220	..	19·01	26	..	20·98	37	..	9·79	283	..	17·04
Stomach	246	2	21·25	33	..	26·63	45	..	11·91	324	2	19·51
Hernia	23	..	1·99	6	..	4·84	9	..	2·38	38	..	2·28
Diarrhœa	650	..	56·16	66	..	53·26	62	..	16·41	778	..	46·86
Jaundice	571	..	49·34	49	..	39·55	59	..	15·62	679	..	40·91
Diseases of liver ..	155	7	13·40	12	..	9·68	27	1	7·14	194	8	11·69
Other diseases ..	357	4	30·85	56	1	45·20	82	2	21·70	495	7	29·82
Total	2,307	13	199·35 ±2·29	262	1	211·44 ±7·14	334	3	88·39 ±2·86	2,903	17	174·83 ±1·88
Men.												
Caries of teeth, &c.	5,680	..	16·84	715	..	28·91	547	..	6·74	6,942	..	15·63
Sore throat and tonsillitis	8,540	2	25·31	1,140	..	46·09	1,307	..	16·10	10,987	2	24·18
Stomach	4,792	9	14·21	443	1	17·91	744	..	9·16	5,979	10	13·46
Hernia	1,818	1	5·39	230	..	9·30	491	1	6·05	2,539	2	5·72
Diarrhœa	14,927	20	44·24	1,596	..	64·53	2,193	..	27·01	18,716	20	42·15
Jaundice	4,657	2	13·80	535	..	21·63	1,002	..	12·33	6,194	2	13·95
Diseases of liver ..	1,367	100	4·05	95	8	3·84	174	16	2·14	1,636	124	3·68
Other diseases ..	7,919	103	23·46	682	5	27·57	1,496	19	18·43	10,097	127	22·74
Total	49,700	237	147·30 ±0·37	5,436	14	219·78 ±1·59	7,954	36	97·97 ±0·62	63,090	287	142·07 ±0·32

The series in order of magnitude is as follows :—

Men	Imperial Yeomanry	219·78
Officers	Imperial Yeomanry	211·44
Officers	Regulars and Volunteers	199·35
Men	Regulars and Volunteers	147·30
Men	Colonials	97·97
Officers	Colonials	88·39

The officers and men, Imperial Yeomanry, show practically the same incidence, as do the officers, Regulars and Volunteers, and the

officers, Imperial Yeomanry. But all the other groups are distinct. The high place held by the officers other than Colonial is to be noted; it may be that it is artificial, in that a greater proportion of those affected may have reported sick than in the case of the men. Of course in such a group as this where many of the complaints are often trivial, it cannot be expected that the records of the hospitals shall give the actual prevalence among the men, and the series appears to show that indifference to minor troubles was an element in determining the peculiar distribution.

The only important difference is that between the officers and men of the Regulars and Volunteers, and this is largely accounted for by the difference in the prevalence of jaundice (35·54 per 1,000) and to a lesser degree in that of diarrhœa, and diseases of the liver and stomach. If the incidence-rates for the different diseases shown in the table are arranged in order of magnitude, there is very little similarity between the lists. But a few points are worthy of remark.

Taking the two diseases in which the conditions of service and the stringency of the inspection of recruits might be expected to have some influence, *caries* and *hernia*, the men of the Imperial Yeomanry show a distinctly higher prevalence than any other group, probably to be explained on these grounds. As regards *caries*, the Colonial officers showed by far the smallest incidence. As regards *hernia*, the officers, as might be expected, always showed a smaller prevalence than the men. In *diseases of the stomach, including dyspepsia*, the officers always showed a higher incidence than the men, the same thing is more distinctly shown in *diseases of the liver*. In *diarrhœa*, the men of the Imperial Yeomanry show the greatest prevalence, next officers of the Regulars and Volunteers, and lastly the men. Altogether the distribution of these diseases is very curious; there was probably some extraneous influence at work which affected it, but nevertheless, it appears that the officer, on the whole, is more likely to suffer from disease of the abdominal organs to such a degree as to incapacitate him than the man.

The mortality ratios have not been worked out; it appears unnecessary to add anything to what has been said on this point.

Caries of the teeth and its accompaniments, including pyorrhœa alveolaris, was much more important than is shown by the admissions to hospital. It is a very serious matter in relation to inefficiency, and is one of several things for which the only remedy is preparation during peace. There is among men with the colours not only a considerable prevalence of dental caries, but a septic condition of the mouth is almost more common.

Much can be done by training the men to use a tooth-brush regularly, and the dental treatment now available is not only highly

appreciated by the men, but decidedly effective in improving their condition. Observation leads to the conclusion that in the long run it will not pay to admit of much relaxation in the conditions affecting the dental efficiency of the recruit.

Of 6,942 admissions for caries, &c., to hospital, about one-third were invalided to England, the remaining two-thirds were nominally returned to duty, but many of them were unfit for duty in the field and had to be retained within reach of soft food.

Diarrhœa.—Major Erskine, among others, remarks on the depressing effect of this disease in a considerable proportion of cases. There is no evidence of the true nature of these cases, which may have been of a specific type.

Jaundice.—This was described by Major H. B. Mathias, D.S.O., as *epidemic catarrhal jaundice*, which it resembled in many respects. The cause appears to be unknown. Some authorities hold that a proportion of these cases are caused by *B. typhosus*, by the two varieties of the paratyphoid organism, and by *B. coli communis*. This would correlate the prevalence with that of enteric fever. All that can be said here is, that some investigations carried out to this end during the War failed to produce any evidence of the connection. It may be added that jaundice is not uncommon in South Africa at all times.

Hepatic abscess has already been discussed. (See p. 170).

Diseases of the Lymphatic System.—Incidence 5·05 per 1,000, as against 23·8 in the previous decade. The decrease is probably correlated with that in venereal sore and gonorrhœa.

Diseases of the Urinary System.—Incidence 4·13, mortality 0·13 per 1,000, as against 2·4 and 0·18 respectively during the previous decade. Of 1,829 admissions and 60 deaths, nephritis of one kind or another accounted for 752 admissions and 50 deaths. Exposure and chill were probably effective in producing these results. Of the remainder, 282 cases and 3 deaths were due to cystitis. The rest were due to various causes.

Diseases of the Generative System (including soft chancre).—Incidence 17·15 per 1,000, as against 35·6 in the previous decade. The principal causes of admission were: stricture, 1,167 cases; varicocele, 1,074; orchitis, 2,119; while other diseases caused 1,289 admissions. No doubt the greater part of the decrease occurred in the admissions for soft chancre and orchitis of gonorrhœal origin, which is often returned under this heading instead of that of gonorrhœa.

Venereal Diseases.—These show an enormous reduction as compared with the previous decade, 38·64 as against 224·6 for syphilis and gonorrhœa alone. The distribution of the cases is shown in the table on p. 202.

VENEREAL DISEASE.

Officers.

	Regulars and Volunteers		Imperial Yeomanry		Colonials		Total	
	Cases	Ratio	Cases	Ratio	Cases	Ratio	Cases	Ratio
Syphilis ..	29	–	4	–	5	–	38	–
Gonorrhœa..	64	–	11	–	24	–	99	–
Soft chancre	7	–	2	–	7	–	16	–
Total ..	100	8·64 ± 0·17	17	13·72 ± 2·03	36	9·52 ± 0·98	153	9·00 ± 0·46
Men.								
Syphilis ..	7,202	–	361	–	1,057	–	8,620	19·41
Gonorrhœa..	6,326	–	470	–	1,742	–	8,538	19·23
Soft chancre	1,550	–	90	–	329	–	1,969	4·43
Total ..	15,078	44·67 ± 0·16	921	37·24 ± 0·73	3,128	38·53 ± 0·40	19,127	43·07 ± 0·19

The series in order of magnitude is as follows:—

Men	Regulars and Volunteers ..	44·67	This difference is distinct.
	Colonials	38·53	This difference is not distinct.
	Imperial Yeomanry ..	37·24	
Officers	Imperial Yeomanry ..	13·72	These ratios are indistinguishable on the figures available.
	Colonials	9·52	
	Regulars and Volunteers ..	8·64	

The striking point is the difference between officers and men, too large to be determined by extraneous circumstances. The greater incidence among the men, Regulars and Volunteers, is probably due to a greater prevalence of secondary syphilis among the regular troops, as it is only among them that the admissions for syphilis are greater than those for gonorrhœa.

Syphilis is widespread throughout Cape Colony among the native population, and, as in the case of small-pox, municipalities spend money on preventive measures—very strong evidence of their importance. Venereal disease was extremely prevalent in Cape Town immediately before the war, and most of the disease shown in our records must have been contracted there.

Two important causes of the decrease were hard work and temperance.

Diseases of the Organs of Locomotion.—Incidence 15·18, mortality 0·02 per 1,000, as against 11·0 and 0·03 respectively, during the previous decade. Inflammation of joints accounts for about half the admissions, largely due to the incidents of the campaign.

Diseases of the Connective Tissue.—Incidence 17·18, as against 30·6 per 1,000 in the previous decade. More than half the admissions were due to abscess. There is no obvious explanation of the decrease, except indifference to trivial affections.

Diseases of the Skin.—Incidence 29·65 per 1,000, as against 53·4 in the previous decade. The great decrease during the War is difficult to explain, except on the ground that the men took such ailments as a matter of course and did not report sick.

Veldt-sore.—This was an important element, perhaps not so much in producing admissions to hospital as in causing discomfort. Much has been written on the subject, without any very definite conclusion being attained. It is unnecessary here to enter into any discussion of the various theories, as distinct evidence in favour of one or the other is wanting. The origin appears, however, to be in all probability bacterial. Major Smith takes this view, he says :—

"As ordinarily seen—a scabby sore with pus exuding from under the hard scab—the ulcer probably nourishes various bacteria not necessarily concerned in the etiology. We base our belief as to the microbial origin on the results of treatment. For we have found that ointments, lotions, &c., applied in the way commonly adopted by the sufferers have little effect. The disease goes on for months, healing here and extending there, while medicaments are carefully placed on the top of the scabs. Whereas, if the scab be removed, the skin snipped off over the inflamed area, and the ulcerated surface thoroughly cleaned—a very simple matter—one, or at most two, applications of crude carbolic will cure the complaint. A strong perchloride lotion, or probably other germicides, will have the same result. So certain in effect is this that some of us while serving with regiments have found that the regimental orderly was able to deal with all veldt-sores when once he had been instructed in the method. The cleaning process was very easily carried out with a piece of wet lint, after the scabs were lifted off and the loosened epidermis in the inflamed area clipped away, so as to allow the remedy to reach every part of the sore.

"One of us (F. S.) describes what he believes to have been a pure veldt-sore on the palmar surface of his own thumb. A small, itching, flat papule appeared. In the centre was a moist speck. Thinking this might be the veldt-sore he allowed the thing to go on for five or six days. It spread slowly from the margin until it was about the size of a fourpenny bit, when it presented the following appearance :—

"(*a*) Minute opening exuding clear fluid.

"(*b*) Whitened layer of epidermis, separated from the layer below.

"(*c*) Red spreading margin.

"He was not in a position to make a microscopical examination at the time. The sore continued to itch greatly. It looked not unlike an umbilicated vaccination mark. Finally, he clipped off the dead skin (*b*) to where it joined the red areola, wiped away the

clear, moist fluid underneath, touched the surface with carbolic, covered up the part with aseptic lint and plaster. On removal of the dressing two or three days later, nothing remained but the dried scar, and that speedily disappeared without further treatment.

"Such a sore as the above on the dorsal surface of the hand of a cavalry soldier would soon have the skin broken, various organisms would get into the sore, and the ulcer would go on from bad to worse. We have no reliable statistics to show that the men of the cavalry suffer more than the infantry, though we have thought this to be the case. If it be so, it need not necessarily be on account of infection coming from horses or anything connected with them, but might be owing to the more frequent abrasion of the hands among the mounted men. Moreover, the men of the cavalry have, we should say, little opportunity of looking after and keeping clean such abrasions. The veldt-sore was common enough among the infantry in the Transvaal, and we have seen officers with the disease on their faces, ears, &c.

"Though not in itself a serious disease, the veldt-sore, when neglected, leads to a good deal of misery and some amount of more or less permanent disfigurement."

CHAPTER XVI.

General Injuries.

The only injuries coming into the medical history of the campaign are those due to *the effects of heat.*

The Effects of Heat.

(1) Sunstroke, heatstroke, and heat apoplexy are known to be relatively rare in South Africa as compared with other regions of high temperature. During the twenty years 1879-1898, which includes the Zulu and first Boer Wars, out of a total average strength of 92,851, only 28 cases of these three diseases occurred, or 0·3 per 1,000, of which but 3 were fatal. These 28 cases occurred in nine separate years; in the remaining eleven no cases occurred.

For comparison we may take the three years 1903-05 inclusive; where in India, in a total average strength of 211,020, the total admissions for all three types were 1,087, with 142 deaths, or a mean annual admission-rate of 5·15 per 1,000, with a case mortality of about 13 per cent.

In the South African War, between October 13, 1899, and May 31, 1902, both inclusive, the total admissions in all ranks for all types of this disease were 1,625, with 15 deaths and 325 invalided out of the country in consequence of the attack, or a mean incidence ratio on the whole strength of 2·68 per 1,000.

The appended table (Appendix, H.) shows the distribution of these cases, 97 of which occurred among the officers, 1,528 among the other ranks.[1]

(2) (*a*) *The Relative Incidence in the various Groups in Series of Decreasing Severity.*

	Officers		Other Ranks	
Imperial Yeomanry ..	8·07 per 1,000	± 1·56	5·28 per 1,000	± 0·28
Regulars, Volunteers, and Imperial Yeomanry	5·35 ,,	± 0·40	3·07 ,,	± 0·06
Regulars and Volunteers	5·05 ,,	± 0·41	2·90 ,,	± 0·06
Total strength, all classes	4·99 ,,	± 0·34	2·79 ,,	± 0·05
Colonial Troops	3·79 ,,	± 0·62	1·56 ,,	± 0·08

[1] The ratios in the table have not been corrected in the same way as those in the other tables; but their relation to one another is practically correct.

The sequence is the same in both officers and other ranks.

(*b*) *The Relative Incidence in Regulars and Volunteers compared with the Imperial Yeomanry.*—Officers: The actual difference (3·02) is not significant in relation to the probable difference (1·61). Other ranks: The actual difference (2·38) is about eight times the probable difference (0·29) and is distinctive. The Imperial Yeomanry rank and file had then a considerably higher incidence than the Regulars and Volunteers. Further, the exposure of the Imperial Yeomanry did not begin till the early months of 1900, while, as will be seen later, the greatest degree of prevalence during the campaign occurred during the first six months of the war. Hence the comparison should be made for the same period of exposure; this is done later, and the result is that the difference is somewhat greater than is shown here.

(*c*) *The Relative Incidence in Regulars and Volunteers compared with the Colonial Troops.*—Officers: The actual difference (1·26) is not significant in relation to the probable difference (0·74). Other ranks: The actual difference (1·34) is about thirteen times the probable difference (0·10), and is distinctive. The Colonial troops then had a considerably smaller incidence than the Regulars and Volunteers, and therefore much less than the Imperial Yeomanry.

(*d*) *The Period of Exceptional Incidence.*—It will be seen later that the greatest proportion of cases among the Warrant and N.C.O.'s and men of the Regulars (and Volunteers) occurred during the hot season 1899-1900. Out of 1,206 cases of all types in the Regulars and Volunteers, 372 occurred between October 13th, 1899, and March 31st, 1900, leaving 834 cases which occurred during the period April 1, 1900, to May 31st, 1902. These give *annual* incidence-rates per 1,000 as below :—

(*i.*) October, 1899, to March, 1900 7·52 ± 0·26 per 1,000
(*ii.*) April, 1900, to May, 1902 .. 2·28 ± 0·05 ,,

Now up to the end of March, 1900, the numbers of Imperial Yeomanry were small, nor were they exposed to the same extent as the other troops, and for these reasons the whole 162 cases in that corps occurred after March, 1900. We then have for comparison annual incidences as follows :—

Regulars and Volunteers, April, 1900, to May, 1902 2·28 ± 0·05 per 1,000
Imperial Yeomanry, April, 1900, to May, 1902 .. 5·28 ± 0·28 ,,

or for concurrent periods of exposure, the incidence in the Regulars and Volunteers was about half that in the Imperial Yeomanry.

(*e*) *There are, then, four distinct differences in regard to incidence :—*

It was considerably greater in the officers than in the other ranks, except in the Imperial Yeomanry.

As regards the other ranks alone, it was much greater in the Imperial Yeomanry than in the Regulars and Volunteers.

It was greater in the Regulars and Volunteers than in the Colonial troops.

The incidence in the first five and a half months of the war was much greater than in the corresponding seasons of the following years.

The last difference is of course not of the same type as the first three; it is associated with certain definite conditions which can be comparatively accurately specified, as will be seen later. It depends on variations in exposure in the same body of men, while the others depend on variations between groups submitted to similar exposures.

This rate of October, 1899, to March, 1900 (in the Regulars and Volunteers) is of course only comparable with rates for corresponding periods in the following years :—

		Actual difference	Probable difference
October to March, 1899-1900 ..	7·52 ± 0·26 ..	— ..	—
,, 1900-1901 ..	3·92 ± 0·14 ..	3·60 ..	0·29
,, 1901-1902 ..	3·48 ± 0·13 ..	0·44 ..	0·19

That is, in the two later periods, the rates are practically identical, and only a little more than half that which obtained during the first period, when the incidence was almost entirely among the Regular troops, as the Volunteers were too few to influence the results, and the Regulars contained a larger proportion of older "seasoned" men than at any other time. The Imperial Yeomanry are included in the later periods; as their general liability was greater than that of the Regulars, the actual rates shown in these two periods are slightly less favourable in comparison with the Regulars and Volunteers in the first period than was actually the case.

After the end of March, 1900, the various groups were subjected to identical conditions as regards exposure, fatigue, and privation; there was no essential difference in their clothing or equipment. But the Yeomanry and the Colonial troops differed in two respects from the Regulars and Volunteers: (1) they were almost all mounted men, and (2) they were better paid. Now it is quite possible to argue that in the first particular they should have been less liable to suffer from the effects of heat, and in the second that through the indirect results of the possession of money to spend—the possibility of obtaining drink—they were more liable to suffer. But these hypotheses will not meet both cases, increase in the Yeomanry and the decrease in the Colonials, unless we invoke the aid of some other factor. In the case of the Colonials, this may have been and probably was acclimatisation, using that term in a

wide extension. In the case of the Yeomanry, some factor, possibly the second noted above, more than counterbalanced any possible advantage due to the first. Here, too, it may be said that the Yeomanry were largely composed of men fresh from England, but on the other hand, the Regulars and Volunteers had, as time went on, an increasing proportion of young and immature men, while their highest incidence rate was at a time when the proportion of young men was the smallest throughout the whole campaign. It does not seem possible to strike a balance between these various factors, and so give any explanation of the difference in incidence which will agree with all the facts. One other factor remains to be mentioned, the matter of diagnosis. No doubt there was considerable confusion in this respect, as is pointed out below; but this element does not seem to be effective if the totals of all types are considered, the distribution in the various groups in the table is comparatively regular.

The difference between officers and men in each group is also difficult to account for. There is little to be said on this point which has not been said above. Probably officers were on the whole rather more exposed than the men; whether this is sufficient to account for the difference in incidence is doubtful.

(3) *Deaths.*—The fifteen fatal cases were distributed as follows: Sunstroke, 10 in 1,018 cases, including two officers; one case died in hospital. Heatstroke, 1 in 504 cases. Heat apoplexy, 4 in 71 cases; one case died out of hospital.

The *case mortality* is less than 0·1 per cent. of all cases. The numbers are too small to allow of any statistical treatment.

The *geographical distribution* was quite irregular. Two deaths occurred at sea, which are noteworthy from the rarity of this affection on the high seas.

The *seasonal distribution* is curious. Four occurred in the quarter January to March (hot weather), four in the period June to August (cold weather), two in April and one in September, which may be termed intermediate months. Four cannot be distributed. Season appears, then, to have been without influence on the death-rate.

Particulars of the period under treatment are available in thirteen cases: Two died out of hospital, *i.e.*, suddenly; three after two days in hospital; one after four days in hospital; one after five days in hospital; two after seven days in hospital; four between twelve and fourteen days in hospital. That is, the majority died, not from a sudden disturbance or destruction of the nervous centres, or from cardiac failure, but from pathological changes of slower development. Seven of the deaths occurred in 1900, the remaining four of which full particulars are available, in 1901.

There is little to be gained by further discussion of so small a number of cases.

(4) *The Validity of the Distinction between the different Types of Disease.*—It may be said at the outset, that there appears to be no possibility of differentiating between heatstroke and heat apoplexy, and one is relieved to find that in the last edition of the nomenclature of the Colleges of Physicians and Surgeons, a source of confusion has been removed by the exclusion of the latter term.

If one examines the manner in which these various terms are used in the text-books, the only possible conclusion is that the actual pathological conditions to which any one of these may be applied must remain largely a matter of conjecture. But in practice, at least in the Service, it appears to be the custom to apply the term sun-

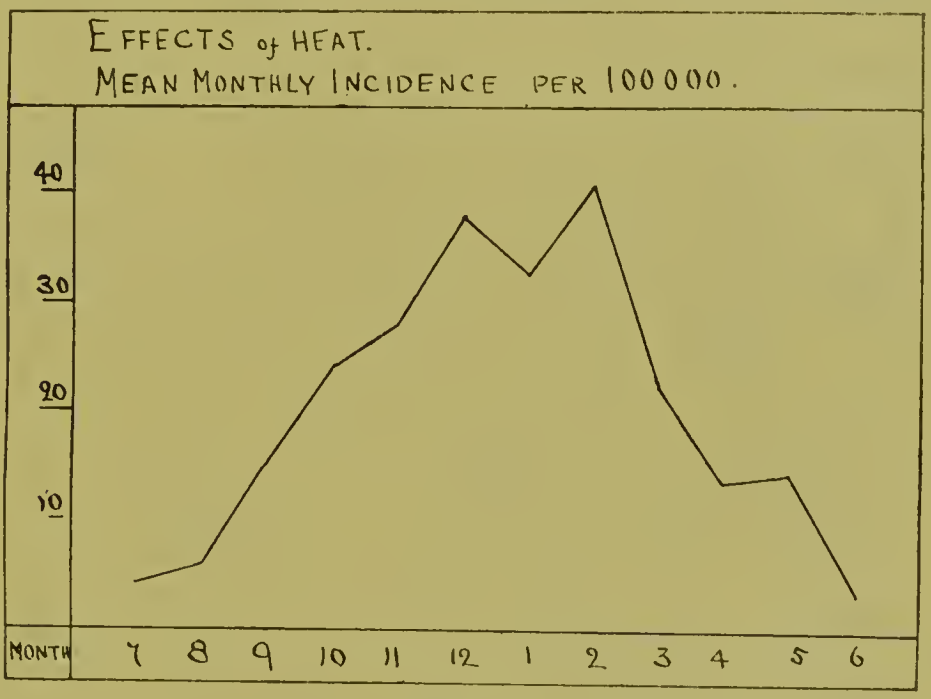

FIG. 15.

stroke to the pathological state arising within a comparatively short time after actual exposure to the sun, and the term heatstroke when this antecedent is absent. This is no doubt the reason why the proportion of sunstroke during the war remained in all the groups considerably, and occasionally greatly above the proportion of heatstroke, as the history of exposure was almost always available. But there is so much confusion in the nomenclature of these pathological states, that a comparison of the relative proportions of each type of disease in each of the various groups does not appear to be profitable. Hence the admissions will be dealt with as a whole, and little attention paid to distinctions between types.

(5) *The Seasonal Distribution throughout the Year; Aggregate of the whole Period.*—This is most easily seen in the diagram, fig. 15, where the incidence is shown (for convenience of plotting) per 100,000 on the mid-monthly strengths. Two points are evident: The greater incidence in the hot weather months, October to March, with a smaller incidence persisting throughout the rest of the year.

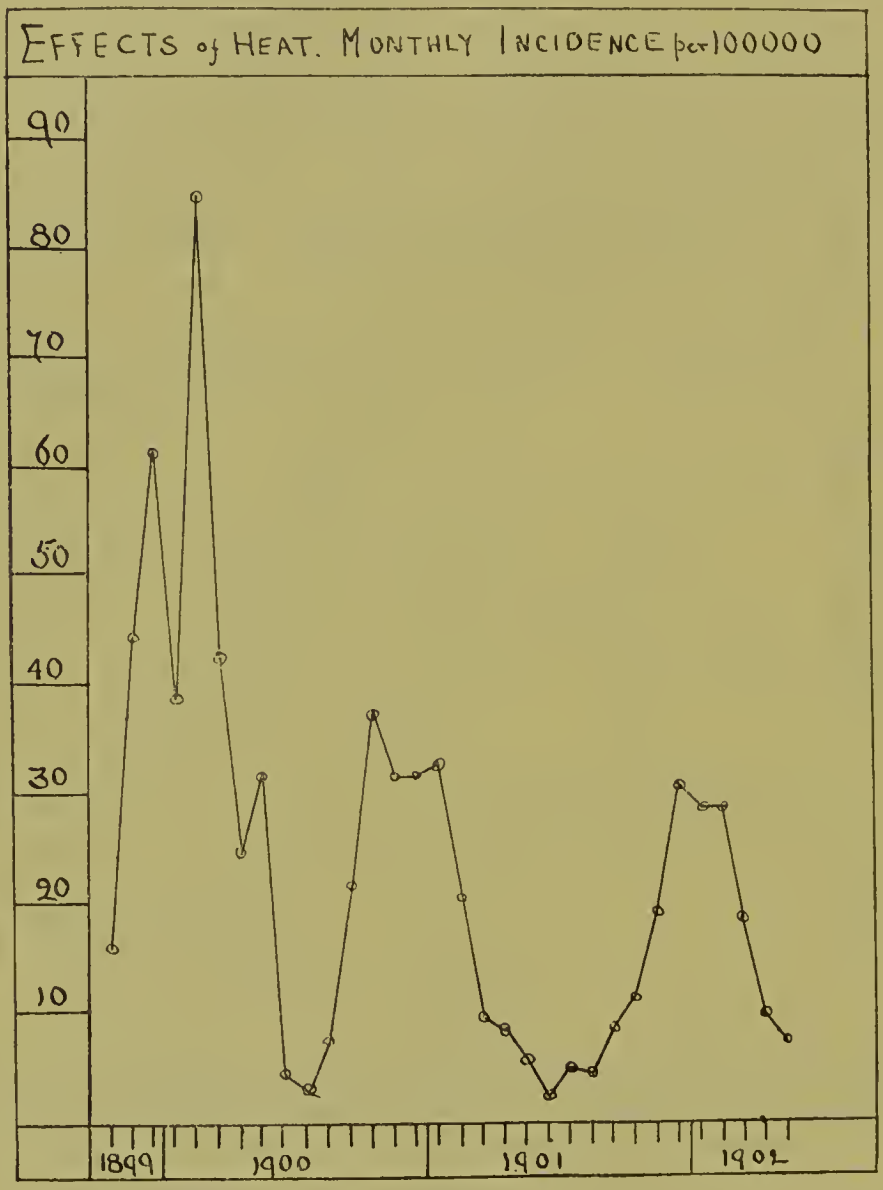

FIG. 16.

Secondly, the month of maximum severity was February, in which the incidence was 43 per 100,000. Investigation shows that the decrease in January is probably accidental, not an expression of fact, as the actual differences in the rates in December and January are not significant as compared with the probable differences. Hence the curve should show a steady ascent to the maximum in

February, followed by a comparatively rapid fall. This curve, of course, shows the actual seasonal distribution *during the war*, not the normal distribution, where, as may be seen in fig. 16, the maximum is in October—November, the period of hot winds.

(6) *The Monthly Incidence throughout the War.* (See fig. 16.)

Three elements affect this incidence :—

(*a*) The strength of troops : (i) Total strength in the country ; (ii) local strengths, *i.e.*, distribution.

(*b*) The severity of the military operations.

(*c*) Climatic conditions: (i.) Seasonal variations ; (ii.) local variations.

(*a*) *The Strength of the Troops.*—(i) In the country. Material variations occurred during the first months of the war, necessitating the employment of mid-monthly strength in calculation. But for this, it would have been sufficiently accurate to make use of the actual numbers of cases. (ii.) Local distribution was important. The concentration on the western line in the hot season of 1899-1900 resulted in a high prevalence there as compared with other seasons. As it is impossible to obtain local strength, the geographical distribution (*vide infra*) is materially obscured by this factor, as actual cases alone can be considered. But the geographical distribution of the troops cannot be neglected entirely ; this concentration near Kimberley is a case in point. Local distribution was also related to the next factor.

(*b*) *The Degree of Severity of the Military Operations.*—This has, of course, always been recognised as an important factor in relation to the prevalence of the diseases dealt with here. In the South African War, variations occurred both in time and space.

The results of these operations were :—

(i.) *Direct effect :* Unusual muscular exertion and resultant fatigue. (ii.) *Indirect effect :* (*a*) Interrupted and lost sleep ; (*b*) irregularity and occasional deficiency in the supply of food and water.

Of these, probably the most important is the direct increase in muscular exertion, under unfavourable conditions. The recent observations of Drs. Haldane and Pembrey, and the observations of others at earlier dates, have shown the very important effect of muscular work on the internal temperature of the body, especially where the air temperature is high and the clothing is not of the very lightest description. "It has also been clearly proved by Dr. Sutton, of Oxford University, that the respiratory exchange, and consequently the heat production in the body, rises very markedly with even a slight increase in the rectal temperature. Hence the heat loss cannot catch up the heat production, and the body is in a vicious circle." (Haldane, *Science Progress*, January,

1908, p. 393.)[1] Dr. Haldane's experiments show how the body temperature continues to rise while the temperature of the air continues constant, provided the wet-bulb temperature is over a certain "critical point." This tendency of the body temperature to continue to increase while the exposure continues, must be a most important element in the production of those effects which are variously called sunstroke or heatstroke.

This rise of temperature may be due to a high air temperature alone (especially a high wet-bulb temperature), with little or no external work, or to the effects of external work while exposed to an air temperature which is high, but not so high as in the first case. Dr. Haldane's observations have shown that the two terms, work and external temperature, are to some extent interchangeable, that is, that the critical temperature falls when the subject is at work, and rises when he is at rest, especially in moving air, or the combined influence of these two factors forms a constant, possibly so far ill defined. Hence, one may use such a phrase as the "intensity of exposure" to express the resultant of the two factors—work and external temperature.

The soldier on service is of course required not only to undertake severe muscular exertion in marching, but in carrying a considerable weight, while at the same time he is hampered to some degree by his equipment. No arrangement can ever be devised which will leave all his movements as free as those of a man who does not need to carry rifle, ammunition, and food, the irreducible minimum.

It is a familiar observation that the effects of heat are commonest when troops are moving in close order, as in column on the march, where the centre of the column gets less air than the sides or ends. During the actual fighting, the same close formation did not exist; the rapid advance in open order was followed by periods, often prolonged, in which the men were more or less prone on the ground, or at least in such a position that they were situated in the lowest stratum of air, of smallest velocity and highest temperature, where they received the full radiation from the ground, at times when a stone or rock was too hot to touch with comfort. Under these conditions, unprotected parts of the body—arms, or legs—became highly inflamed from the direct action of the sun, an action which personal experience even on Table Mountain has shown to be severe.

It is evident that the more the men are exposed to such conditions the more likely are they to show a febrile reaction

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[1] See also Dr. Sutton's article in the *Journal of Pathology*, July, 1908.

which may assume the form usually described under one of the types dealt with here, possibly with cardiac or cerebral symptoms, or may manifest itself as a comparatively mild febricula of short duration. A proportion of the cases of simple continued fever which occurred on the march to Bloemfontein appear to have been of this nature; such at least was the opinion of those who saw them at the time, and their rapid and complete recovery when placed under more favourable conditions corroborates this.

(ii.) The "indirect effects" are more directed towards the depreciation of the general "fitness" of the soldier, that is, his power of accommodating himself to rapid changes either in his surroundings (in this special case, external temperature), or in his internal work, especially that of the heart. As a matter of common experience, prolonged irregularities, either in food or sleep, undoubtedly diminish this accommodation, in some cases permanently during the duration of the conditions, in others of higher adaptability, till a still higher degree of accommodation has been attained. During the later stages of the campaign, a large number of the men had attained this degree of accommodation, as in many laborious trades and occupations where men appear to be perfectly healthy under circumstances which would break down the new hand without this practical training. It is possible that this may be, in fact, not due to any higher adaptability of the body, but to the art which has been acquired of doing work in the most economical way, with the least expenditure of energy, and this certainly appears to be a most important factor in the greater resistance of the war-trained soldier.

(*c*) *Climatic Conditions.* (i) *Seasonal variations*: Of these the most important are:—

(1) The conjunction of the hot and the rainy season throughout the greater part of the area of military operations.

(2) The extreme dryness throughout the remainder of the year. At all times of the year there is normally a brilliant sun, and usually some considerable movement of the air.

(ii.) *Local variations*: The greater part of the area of operations had the same general character, that of an open upland plateau, from 3,000 to 5,000 feet above the sea. The only important exceptions were the Krokodil Valley (from which only three cases were reported, all sunstroke), the Barberton Valley (two cases, sunstroke), and a few shallow valleys such as that in which Pretoria is situated, Rustenburg, and certain other small places; the coast-belt of Cape Colony (which is in the area of the winter rains, and so differs from the rest of the area), and the low ground in Natal.

It is, of course, impossible to get any meteorological statistics

relating to any great part of the area of operations during the war. The meteorological records in South Africa have been somewhat imperfect; the report of the Cape Meteorological Commission gives particulars regarding a number of stations, few of which, however, are of much value in this connection; similarly, the report of the Government Astronomer in Durban gives some records for Natal. Other partial records are also available, but none which in any way cover the area from which the cases were drawn. We have, then, neither a correspondence in time nor in place between such meteorological records as are available and the record of cases. The meteorological factor can then be stated only in general terms.

Cape Colony is Supan's "Cape" climatic province, sub-tropical. The rest of South Africa is included in his "African Tropical" province. In January, the hottest month, the isotherms form a remarkably regular system of concentric ellipses, whose major axes, situated a little to the east of 24° E. longitude, incline slightly from east to west. Practically the whole of the area of operations in the Transvaal and Orange Free State, Northern Cape Colony, and Northern Natal is included between the January isotherms of 92·5° and 82·5°. The isotherm of 92·5° passes through Kimberley in a north-easterly direction to the Western Transvaal, and it is in this area that the highest recorded air temperatures are met with.

The table on p. 215 shows some observations at certain stations in individual years, gathered from various sources, which give an idea of the existing conditions.

The mean maximum temperatures and the absolute maxima are seen to be really high at times: the actual date of their occurrence is determined largely by the direction of the wind, as in many places the hot, dry winds set in comparatively early in some years. The two points of greater importance in this connection are the absolute wet-bulb temperature and the relative humidity. The wet-bulb reading of 77·7° in Kimberley in 1897 is the highest which has been traced in the material at disposal. Then follow Philippolis (74·3°), Bloemfontein (67·8°), and Hopetown (64·8°) at the angles of an irregular quadrilateral, in which much of the severest work of the campaign was done. The importance of this area will be seen later when the distribution is considered. Kingwilliamstown, with a wet-bulb reading of 71·4°, is in a totally different geographical position, only about 27 miles from the sea. Capetown and East London are also not comparable with the upland stations.

The relative humidity is usually low; in none of the upland stations are the values unusually high, even at the worst. Unfortunately no records are available from the low valleys away from

the coast, which have been mentioned above. One would expect to find considerably higher figures from these areas.

Station	Mean maximum	Month	Absolute maximum	Month	Wet-bulb	Month	Humidity	Month
Kimberley ..	96·3	Dec.	102·8	Feb.	77·8	Dec.	75 per cent.	Dec., 1897.
Hopetown ..	94·5	Dec.	103·0	Nov.	64·8	Dec.	71 ,,	June, 1897.
Johannesburg	85·1	Nov.	95·0	Dec.	61·8	Dec.	68 ,,	Jan., 1897.
,,	79·3	Nov.	92·0	Nov.	58·0	Feb.	80 ,,	Feb., 1904-05.
,,	81·9	Jan.	91·0	Dec.	60·7	Jan.	..	Feb., 1905-06.
Aliwal North	86·4	Dec.	96·0	Dec.	63·0	Dec.	79 ,,	Jan., 1897.
Bloemfontein	91·4	Dec.	97·4	Dec.	67·8	Dec.	78 ,,	June, 1897.
Capetown ..	83·4	Jan. and Feb.	104·0	Mar.	66·0	Jan.	85 ,,	July, 1897.
East London	74·3	Jan.	94·0	Aug.	66·4	Jan.	83 ,,	Feb., 1897.
Kingwilliamstown	84·9	Dec.	108 0	Dec.	71·4	Dec.	82 ,,	April, 1897.
Philippolis ..	86·7	Feb.	96·2	Nov.	74·3	Dec.	68 ,,	Jan. and Mar., 1897
							Relative humidity	
Maritzburg ..	89·4	Dec.	111·8	Nov.			67 per cent.,	Jau., 1897.
							68 ,,	June, 1897.
,,	94·0	Jan.	111·0	Jan.			61 ,,	Feb and Mar., 1906.
Pretoria (Robert's Heights)	84·1	Jan.	91·0	Jan.			67 ,,	Mar., 1906.

Another element which has to be considered in this connection is the actinic power of the solar radiation, to which some observers have attributed those effects of direct exposure which are known as sunstroke. There is a good deal of difficulty in dealing with this point. The first question to be answered concerns the reality of the effects produced by the wearing of garments, or linings to head-coverings or garments, which absorb some part of the radiations of shorter wave-length, reality being taken to mean an actual difference in the physical conditions.[1] There appears to be no doubt respecting the difference in comfort produced by the use of coloured glasses, or better still of smoked glasses, and there is some evidence that red clothing or red linings have an appreciable effect. But it does not seem possible to account for this on a purely physical basis. It is, however, unnecessary to discuss this point here. The second question relates to the actinic value of the light in South Africa, and it is convenient to compare it with the light in this country as a standard. There appear, however, to be no direct

[1] The Report of the Board for the Study of Tropical Diseases in the Philippines shows that no evidence could be obtained that the sun's rays had any influence, and that further, the test clothing (orange red) was useless. (JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, vol. xvi., p. 109 *et seq.*)

observations on this point in South Africa, none at least which are complete and available for discussion. One knows generally that the average value is greater than in England, on account of the lower latitude and the greater clearness of the atmosphere, but the sum of these differences is not great. Comparing an average bright summer day in England with the average South African day, it is probable that the difference between the two is not greater than 3 : 1, and is very possibly less. A good deal of photographic experience in both countries appears to show that, with other conditions as nearly alike as possible, results will be satisfactory on the assumption that the light in South Africa has twice the actinic power of that in England.

It is difficult to say whether or not this difference is practically important in the production of sunstroke. There have been, of course, in England occasions (on manœuvres or route marches) where a heavy incidence of all types of these disorders has occurred. During the last three years the incidence in England of all three types has ranged between 0·13 and 0·42 per 1,000; this incidence is calculated on the total strength in the country, not on those exposed under the special conditions referred to. Now the mean incidence in South Africa in the twenty years ending in 1898 was 0·3 per 1,000, and only in the two years 1886 and 1896 did the incidence exceed (and then slightly) 1 per 1,000.

It is impossible with our present knowledge to separate the actinic from the heating effects of the solar radiation. Generally speaking, the two increase together, but the actinic power decreases before the air temperature, whose maximum is after the greatest altitude of the sun. So, in comparing the South African incidence-rates with those at home, one has to remember that, quite apart from variations in the actinic power, the temperature conditions (whose influence is indisputable) continue to be favourable to the production of these disorders for about twice the time (at least four months) that they are favourable in this country.

It seems difficult to avoid the conclusion that if variations in the actinic power of the light are in any way effective, the results of their action are so insignificant as to be obscured by those of other and more effective agents.

(7) It is not possible to separate the effects of these three factors —strength, severity of the military operations, and climatic conditions—with any degree of accuracy or detail, but certain of the broader features are perfectly distinct.

Fig. 16 shows the monthly incidence per 100,000 for each month of the war. The seasonal distribution is well marked, but most striking is the difference between the incidence during the first year and that in the other two years. We find not only a much higher

rate of incidence, but the continuance of a high rate throughout a prolonged period. From November, 1899, to May, 1900, the rate remained continuously above any other rate except those during the actual hot weather months of the two following seasons; in fact, even in April and May, 1900, the actual admission-rate was not much below the hot weather rate of 1902.

The distinguishing feature of this period of the war, as compared with later periods, was the severity of the military operations in which the troops were engaged. It covers, on the one side, the advance in Natal and the relief of Ladysmith, and the advance of General Buller's force into the Transvaal. On the other side, it includes the operations under Lord Methuen, the relief of Kimberley, the advance to Bloemfontein and to Pretoria. At no other period of the war were so many men exposed to such a degree of fatigue and privation.

It is probable that a certain degree of adaptation to the climate and conditions obtained during the last two years which was wanting in this period; those men who had escaped disease were harder and fitter than in their first year, and beyond this physical improvement there was an adaptation of the means to the end which was absent earlier. Men had learnt by experience how to obtain the maximum of comfort with the poorest materials, and the general conditions of life had in many ways improved. On the other hand, the proportion of young soldiers had increased, and the physique of the reinforcements did not improve as time went on. These reinforcements in gross had the benefit of the experience of the others, but still one may set off immaturity of a larger proportion of the force against the other conditions, and so eliminate both elements, leaving the difference in war conditions as the effective element. This appears to be evident in the following section.

(8) *The Geographical Distribution.* — Materials are available from which it is possible to show the geographical distribution of the cases of each type for the whole duration of the war. Such a statement, however, would be misleading, as it is not possible, for obvious reasons, to bring the numbers of cases into any relation with the strengths or even the periods of occupation of the various stations. A complete statement of these conditions would mean practically a detailed history of the war. It has been shown previously (p. 206) that the incidence during the hot season 1899-1900 far exceeded that in the next two seasons; 372 out of 1,206 cases occurred between October 13th, 1899, and March 31st, 1900, giving an incidence-rate of 7·52 per 1,000, as against 2·28 for the remainder of the war.

On further examination one finds that of these 372 cases, no

less than 306, or 82 per cent., occurred in two groups of men—the army in Natal and that on the western line between De Aar and Kimberley. Of this 306, 216 occurred on the western line, and 90 in Natal. One must again, unfortunately, deal only with numbers, not ratios, but even here a distinction is to be observed between the two areas. On the western line, of the 216 cases, 101 occurred at Modder River, and 51 at Orange River; these were, of course, the points at which the greatest concentration of troops took place, but it is to be noted that at Modder River 57, or more than half the cases, occurred in February at the beginning of the operations for the relief of Kimberley. The distribution on the western line for this month of February shows the places through which troops were passing, and round which operations involving severe exposure and fatigue were taking place.

In Natal, the concentration of cases in close touch with active operations is not so striking. Ladysmith contributes only eight cases in spite of the stress and privation to which the garrison was subjected, a garrison, however, which was almost entirely composed of "seasoned" men. The standing camps at Frere, Chieveley and Maritzburg show the greatest number of admissions, and with regard to the two former stations it is probable that the admissions were in fact cases contracted in the field, which did not pass through the hospitals with the field army. In Maritzburg, however, this was not the case, and the incidence there, especially in March, 1900, was probably due to the facility with which drink was procurable.

It is unfortunately impossible to differentiate the two elements determining the number of cases, the number of men exposed, and the intensity of the exposure. In this particular period, October, 1899, to March, 1900, the bulk of the troops were undoubtedly in the areas from which the 82 per cent. of the total cases during this period were drawn. Outside these areas, the troops were concentrated in much smaller numbers to the south of the Orange Free State and around Stormberg. One then finds that of the sixty-six cases not derived from the two special areas referred to above, an important proportion came from the south of the Free State. The predominant influence of the intensity of exposure cannot then be shown from these instances, in which mere numbers exposed might suffice to account for the distribution of cases, but nevertheless we must remember the meteorological conditions affecting the west and south of the Free State, referred to above.

We have, however, in the comparison of the first with the two succeeding hot seasons a means of comparing these intensities. In neither of the later seasons were the demands on the troops nearly as severe or continuous as those during the operations in Natal

and on the western line. There was no important difference in the meteorological conditions of these three seasons. Yet we see from fig. 16 how far the incidence per 1,000 in the first season exceeded that in the two succeeding seasons, and further, the prolongation of the incidence into the cold-weather months of 1900, when at Bloemfontein in May, at the time of Lord Roberts' advance to Pretoria, a larger proportion of cases was admitted than in any other season.

The admissions at certain stations have been plotted out month by month, but the discussion of these figures appears of very little use without an intimate knowledge of all that was going on in and around these stations. As in other diseases, the investigation of their etiology requires observations *ad hoc* carried on during the period of exposure; the autopsy of the usual documentary evidence can only give imperfect results, which, too, are misleading if the examination be pushed too far into detail.

One of these results, however, appears of some importance in relation to one theory of the etiology of these diseases, and that is the practical absence of all types from the hot, deep, and humid valleys of the Krokodil River and Barberton. From the former only three cases and from the latter only two cases were reported. This did not depend on the absence of troops; both valleys were fully occupied during the last two hot seasons, and the troops on their entry there had a very arduous task.

The following is the general distribution of the cases among the Regulars, Volunteers, and Imperial Yeomanry (not including officers): Sunstroke—Total cases, 858; deduct 31 ("at sea," 8; station or date not known, 23), 827. These 827 cases occurred in 109 stations, an average of 7·6 per station. 565 cases occurred in 20 stations, none of which showed less than 10 cases, an average of 28 cases per station, or 18·3 per cent. of the stations returned 68·3 per cent. of the cases; four-fifths of the stations had only a few cases. Heatstroke—Total cases, 448; deduct 2 "at sea," 446. These 446 cases occurred in 75 stations, an average of 6 per station. 287 occurred in 10 stations, none of which returned less than 10 cases, an average of 29 cases per station, or 13·3 per cent. of the stations returned 64·4 per cent. of the cases. Heat apoplexy—Total cases, 62; deduct 4 "at sea," 58. These 58 cases occurred in 28 stations, no station showed as many as 10 cases. Fifteen stations returned only 1 case each, or 13 stations returned 43 cases; that is, 46·5 per cent. of the stations returned 74·2 per cent. of the cases.

These figures seem to show that the syndrome termed "heat apoplexy," though less prevalent, was more widely distributed than either of the other forms. But, as has already been pointed out,

it is very difficult to accept the validity of the distinction between the various types, and any attempt to draw conclusions from this is therefore futile.

(9) *Accessory Influences: Dress, Food, Drink.*—Dress is always important in relation to the effects of heat. General experience shows that the essentials are that it shall be light in weight but not too thin, loose, especially about the neck and over the chest, and of a colour and material by which the balance between absorption and radiation is satisfactorily maintained. Sufficient strength to resist rough usage at times interferes with one or other of these requirements, as for example, in the case of some of the breeches issued for the Mounted Infantry, which were heavy and very warm. On the whole, however, the service dress in South Africa could hardly have been improved on; it was eminently suited to the climate. At the beginning of the war there was a tendency to too close fitting, and the helmet was generally worn, but these two faults were eliminated very early; the felt hat in particular was far better suited to the climate than the helmet.

Food.—The quantity was usually sufficient, though periods of general deficiency and of partial deficiency did occur. The most important fault was the excessive proportion of meat that was issued at certain times, particularly during the last year of the war.

Drink.—Outside the larger towns, the question of drink was not of much importance, both on account of its scarcity and its cost. It may have been, in fact probably was, an element in increasing the number of cases in such places as Pretoria, Bloemfontein, Capetown, and Maritzburg. Payments to the troops were irregular, and many men, especially those of the Imperial Yeomanry and Colonial Corps, were in possession of large sums of money.

Recapitulation of the Facts.—The chief points may be summarised as follows: (*a*) The incidence per 1,000 of strength during the war was (i.) very much greater than during the previous twenty years in South Africa—2·68 against 0·30 per 1,000; (ii.) about half that in India during the three years 1903-05—2·68 against 5·15 per 1,000.

(*b*) The mortality per 100 cases admitted during the war was less than 0·1 per cent., as compared with about 13 per cent. in India during the three years mentioned. The mortality in South Africa during the twenty years before the war (three deaths in twenty-eight cases) is too short a series for comparison.

(*c*) The relative incidence in the various groups: (i.) The incidence among the officers in the Regulars, Volunteers, and Colonials was distinctly greater than among the "other ranks" of each group, but there is no essential difference between the incidences in the different groups of officers; all suffered to practically the same extent.

(ii.) The incidence among the "other ranks."

The Regulars and Volunteers showed an incidence which was for concurrent periods of exposure (between April 1st, 1900, and May 31st, 1902), about half that in the Imperial Yeomanry—2·28 as against 5·28 per 1,000.

The Regulars and Volunteers showed an incidence which was distinctly greater than that among the Colonial troops, 2·90 as against 1·56 per 1,000.

(*d*) The period of the greatest incidence was during the time of greatest military activity, the first five and a half months of the war. In the group Regulars and Volunteers the incidence during this period was 7·52, as against 2·28 per 1,000 for the remainder of the war.

(*e*) The place of greatest incidence was the area of most intense exposure, that is the western line, with Natal, in which areas 306 cases occurred of the 372 which were reported between the beginning of the war and the end of March, 1900.

(*f*) The seasonal distribution during the last two years corresponded with the temperature curve; during the first year there was an unusual prolongation into the cold weather months.

(*g*) Meteorological observations are imperfect and incomplete, but those which exist show that the area in which the operations for the relief of Kimberley and the advance to Bloemfontein took place is probably a region where the mean maximum and wet-bulb temperatures are at least as high as in any other part of the area of operations.

(*h*) The deep humid valleys of high mean temperature did not show a large proportion of cases. On the contrary, the numbers are probably smaller in proportion to the strength than from other localities. Here the possibility of some confusion with malarial fever must not be overlooked.

(*j*) Accessory causes—dress, food, and drink—had little influence on the general prevalence of these diseases.

Conclusions.—The materials are, as has been shown, imperfect, and for this reason only the broader facts can be dealt with. The following conclusions appear justifiable:—

(i.) In the majority of cases, the etiological factor was the combined influence of exertion and a high external temperature. This appears evident from the distribution of cases in time and space. There appears to be no need to introduce the hypothesis of an unrecognised organism to account for the facts.

(ii.) Positive evidence of the influence of the actinic power of the sun is wanting; analogy leads one to believe that this influence can at most be only secondary.

(iii.) There appears to be a probability of some degree of accom-

modation, of the acquisition of an increased power of resistance to the disturbing effects of exposure, seen in the small incidence on the "seasoned" garrison of Ladysmith, the differences between the three groups—Colonials, Regulars and Volunteers, and Imperial Yeomanry. Part of this is certainly not vital, but the result of economy of labour due to experience; part, however, may be due to a readjustment of the regulating mechanisms of the body, as in the case of stokers, puddlers, and others employed in similar occupations.

(iv.) The mortality among the cases was so small (under 0·1 per cent.) as compared with India, that it suggests a great difference in the type of disease. If the differentiation of types is to be relied on, heat apoplexy in South Africa was as usual the most fatal, but even here the death-rate—four deaths in seventy-one cases—was low. One has to remember in relation to this possible difference in type that in South Africa the period between sunset and sunrise is at its worst comparatively cool, and that for this reason the exposure to a temperature which is detrimental is always shorter than it is in India.

This appears to be the only particular in which these diseases in South Africa differed from similar diseases elsewhere, the comparatively small morbidity and very low mortality. In respect of other particulars, there was little departure from the results of previous experience, but the prolongation of the campaign through three hot seasons enabled one to see more distinctly than is usually the case, the close association between excessive exposure and incidence, and the effect of accommodation. The case was simplified, too, by the absence of malarial fevers from the greater part of the area of operations. In no previous campaign in a hot climate has such an opportunity been afforded.

Lightning stroke caused 206 admissions and sixteen deaths, all out of hospital. Of the remainder of the cases, fifty-three were invalided. The incidence is remarkably small taking into consideration the frequency of severe storms and the absolute want of protection.

Poisons.—Alcohol accounted for thirty-four admissions, with nineteen deaths, and for seventeen deaths out of hospital. The cases were definitely of the type of acute poisoning, the result of accidental access to a quantity of spirit. Exposure to considerable cold was no doubt frequently effective in some of these cases. The most interesting feature here is the appearance of a new habit, *i.e.*, cordite eating, which, however, was not widespread, and apparently mainly confined to those who were in the habit of using drugs. Major Smith says (and see also Major Jennings, D.S.O., JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, vol. i., p. 277):—

"*Cordite Eating.*—The *cordite habit* appears as a new disease

—an outcome of this war. It seems to have been generally talked about, but definite information was wanting. The Principal Medical Officer of No. 2 General Hospital had it in his mind in connection with disordered action of the heart, but he had to report that no man had been discovered eating it in his hospital."

Major J. W. Jennings, D.S.O., and Captain H. M. Morton, both of the Royal Army Medical Corps, made a special inquiry into the matter, and have presented a special report of which the following is an epitome; interesting, not only as a description of the immediate effects of the drug and the later results of the cordite habit, but also in showing how extraordinary and unlooked-for may be the bye-products of war.

"Such a trifling matter as a dearth of matches led to a knowledge of the drug. For the men extracted the cords from the Lee-Metford cartridges to light their pipes and cigarettes with, and found that it affected their heads. Thus it may be supposed the fatal knowledge would arise and spread. The craving for drink, which could not be had in the field, would conduce to the use of the narcotic, once it became known.

"The drug is taken in two or three ways, *e.g.*, eaten solid, boiled down in water or tea, or mixed with beer.

"In small doses to those unaccustomed to its use, or to other narcotics, cordite, like some other drugs, has a by no means pleasing effect, as Major Jennings found to his cost on eating a quarter-stick by way of experiment. The stuff was sweet in the mouth, but it gave him a "most racking, splitting headache." The *habitué* is able to take the contents of a cartridge or more. His face flushes, head throbs, and seems to swell, and then in about fifteen minutes, comes long deep sleep. On awakening he has an intense headache, thirst, &c. Taken with beer or hot tea, the first effects are wild delirious intoxication, and this is followed by sleep. Morphia, opium, and alcohol in *small* quantities are "pick-me-ups" after cordite; and apparently some men have used cordite as a reviver after alcohol. Optical and mental delusions, timidity, weakness, and general breakdown, moral and physical, result from prolonged use of cordite as a drug."

CHAPTER XVII.

Conclusion.

The Influence of Climate on the Incidence of these Diseases.—Confining our attention to those diseases which are not epidemic in character, we have in the South African War an example of a campaign carried on in a country in which the climatic conditions are entirely favourable. The troops at the end of the War formed, perhaps, the healthiest body of men that has ever been seen. True, they were rather "fine" as a result of their exertions, but physically and mentally they could not have been better.

The whole conditions of the campaign were, however, so unusual that it is difficult to say how far our experience there is likely to assist us in other and less favourable climates. There is little doubt, for example, that the effects of exposure to the elements were in South Africa less detrimental than they would be in Europe, probably because of the greater dryness of the atmosphere and the more continuous sunshine. Men were not drenched with cold rain for days at a time as our experience sometimes is in this country. On the other hand, the intensity of the heat was mitigated, as compared with a tropical climate, by the prevalent breezes and the cool nights. The fact that these conditions were favourable, however, emphasises the effects produced by the stress of a campaign. These effects may be divided into two classes: those due to exposure, diseases of the respiratory and urinary systems and rheumatism, and those due to hard work under unfavourable conditions, diseases of the nervous, of the circulatory, of the digestive system, and of the organs of locomotion. There is little doubt that in such a climate as England, the effects of exposure would be of far greater importance, while in the second group the effect of differences of climate can only be indirect.

The Components of the Force in relation to Disease Prevalence.—In this campaign we have an opportunity of studying the incidence of disease in three bodies of men, to a great extent different in origin and composition (see also Chapter XI.), each large enough to give a close approximation to true results, and all (with one minor exception) exposed to infection and to other, adjuvant, causes of disease in the same degree. The minor exception is in the lesser exposure of the Imperial Yeomanry to malarial infection.

The first of these bodies, the Regulars and Volunteers, was composed as follows: Regulars 74 per cent., Militia 18 per cent., Volunteers 8 per cent. Further, the period of exposure of the Regulars was greater than in the case of the other two components, hence the statistics relating to this group may be regarded with some confidence, as expressing the prevalence and mortality in the *Regular Army*. If there is any error in this assumption, the result must be that the sick-rate among the Regulars is even less than that shown here.

In the second group, the Imperial Yeomanry, the principal feature to note here is that they were drawn almost entirely from Great Britain, and were without previous training. There were other differences also in the standard required, and in the examination of recruits. (See Chapter IV.)

In the third group, the Colonial troops, were included men of many different types, from the best to the worst, but the group was characterised as a whole by greater experience of a rough life, away from the resources of a thickly populated country, in which process the weaker elements had been eliminated. They were accustomed to look after themselves to a much greater extent than the other groups, and perhaps also took less notice of minor ailments. On the other hand, in the later stages of the campaign, a proportion of the Colonial troops raised in South Africa spent the greater part of their short period of service in hospital.

These differences in the general characteristics are reflected in the relative prevalence of disease, as shown in the following table.

TOTAL INCIDENCE.

Officers.

	REGULARS AND VOLUNTEERS		IMPERIAL YEOMANRY		COLONIALS		TOTAL	
	Cases	Ratio	Cases	Ratio	Cases	Ratio	Cases	Ratio
Climatic diseases	4,586	369·33 ±2·84	446	359·92 ±5·94	801	211·96 ±4·12	5,833	351·27 ±2·31
Other general diseases	1,562	135·00 ±1·99	217	175·12 ±4·71	405	107·17 ±3·12	2,184	131·53 ±1·64
Local diseases ..	3,630	313·72 ±2·70	462	372·83 ±6·05	677	179·14 ±3·86	4,769	287·21 ±2·19
All diseases ..	9,778	845·03 ±2·10	1,125	907·87 ±3·58	1,883	498·27 ±5 42	12,786	770 01 ±2·04
				Men.				
Climatic diseases	123,115	364·87 ±0·51	10,444	422·26 ±1·90	20,422	251·55 ±0·91	153,981	346·78 ±0·43
Other general diseases	61,311	181·71 ±0·40	5,966	241·21 ±1·65	13,212	162·74 ±0·78	80,489	181·25 ±0·35
Local diseases ..	109,313	323·96 ±0·49	10,865	439·28 ±1·91	18,688	230·18 ±0·89	138,866	312·71 ±0·42
All diseases ..	293,739	870·54 ±0·35	27,275	1,102·75 ±1·23	52,322	641·48 ±1·01	373,336	840·69 ±0·32

TOTAL MORTALITY.

Officers.

	REGULARS AND VOLUNTEERS		IMPERIAL YEOMANRY		COLONIALS		TOTAL	
	Deaths	Ratio	Deaths	Ratio	Deaths	Ratio	Deaths	Ratio
Climatic diseases	186	16·07 ±0·74	21	16·95 ±1·60	37	9·79 ±0·99	244	14·70 ±0·58
Other general diseases	7	0·60 ±0·14	—	—	4	1·06 ±0·33	11	0·66 ±0·12
Local diseases ..	26	2·25 ±0·27	4	3·22 ±0·70	10	2·64 ±0·52	40	2·41 ±0·24
All diseases ..	219	18·92 ±0·79	25	20·17 ±1·74	51	13·49 ±1·36	295	17·77 ±0·64
				Men.				
Climatic diseases	7,710	22·85 ±0·15	757	30·60 ±0·66	1,006	12·39 ±0·23	9,473	21·33 ±0·13
Other general diseases	174	0·52 ±0·02	13	0·53 ±0·09	58	0·71 ±0·06	245	0·55 ±0·02
Local diseases ..	962	2·85 ±0·06	51	2·06 ±0·17	184	2·27 ±0·10	1,197	2·70 ±0·05
All diseases ..	8,846	26·22 ±0·17	821	33·19 ±0·69	1,248	15·37 ±0·26	10,915	24·58 ±0·14

Notes.—(1) N.A.D. has not been included.
(2) The cases and deaths are those recorded; the ratios have been correeted as before.

The following lists of the incidence-rates in order of magnitude are, however, more convenient for comparison.

CLIMATIC DISEASE (*i.e.*, ENTERIC AND SIMPLE CONTINUED FEVER, MALARIAL FEVER, AND DYSENTRY).

Men	Imperial Yeomanry	422 per 1,000
Officers	Regulars and Volunteers	396 ,,
Men	Regulars and Volunteers	365 ,,
Officers	Imperial Yeomanry	360 ,,
Men	Colonials	252 ,,
Officers	Colonials	212 ,,

All these ratios are distinct except those referring to the Officers Imperial Yeomanry, and men Regulars and Volunteers, which are practically identical.

OTHER GENERAL DISEASES.

Men	Imperial Yeomanry	241 per 1,000
Men	Regulars and Volunteers	182 ,,
Officers	Imperial Yeomanry	175 ,,
Men	Colonials	163 ,,
Officers	Regulars and Volunteers	135 ,,
Officers	Colonials	107 ,,

LOCAL DISEASES.

Men	Imperial Yeomanry	439 per 1,000
Officers	Imperial Yeomanry	373 ,,
Men	Regulars and Volunteers	324 ,,
Officers	Regulars and Volunteers	314 ,,
Men	Colonials	230 ,,
Officers	Colonials	179 ,,

All Diseases.

Men	Imperial Yeomanry	1,103 per 1,000
Officers	Imperial Yeomanry	908 ,,
Men	Regulars and Volunteers	870 ,,
Officers	Regulars and Volunteers	845 ,,
Men	Colonials	644 ,,
Officers	Colonials	498 ,,

In this series all the ratios are quite distinct.

"Other general diseases" are seen to take but a small part in the determination of this final sequence, which shows the Regulars and Volunteers holding a position midway between the other groups. It is also to be noted that, in each group, the officers show a lesser incidence than the men.

The sequence in the mortality table for "climatic diseases" and for all diseases is the same as that for enteric fever alone (see Chapter XI.). The mortality series in other general diseases and in local diseases do not show significant variations between the various groups.

As shown above, the Regulars and Volunteers hold a position midway between the other groups. Taking first the comparison with the Imperial Yeomanry, the greater incidence for *all diseases* in the men of the Imperial Yeomanry than in the men of the Regulars and Volunteers amounts to 232·21 per 1,000, made up thus: climatic disease, 57·39; other general diseases, 59·50; local diseases, 115·32. In climatic disease, the Imperial Yeomanry show a greater prevalence in every disease except malaria. In the greater prevalence of local diseases, those of the digestive system are the most important and account for 72·48 per 1,000, of which the following diseases account for 60·97 : jaundice 7·83, diarrhœa 20·29; sore throat and tonsillitis 20·78; and caries of the teeth 12·07. There is also a small excess in nervous and mental diseases and in those of the circulatory system.

Making the comparison with the Colonial troops, the Regulars and Volunteers show an excess in the total admission-rate of 226·06 per 1,000, made up as follows: climatic disease 113·31, other general diseases 18·97, local diseases 93·78.

Among the local diseases the important differences are again found to occur in diseases of the digestive system, 65·66 per 1,000, where the factors are again diarrhœa 17·16, sore throat and tonsillitis 9·21, and caries of the teeth 10·10. Subsidiary causes are: the circulatory system 12·09, nervous and mental disease 4·24, and venereal disease 6·14 per 1,000.

It is obvious from the above statements that the more important causes of the differences in the total admission-rates are, with one exception, comparatively trivial diseases. The exception is, of course, epidemic disease, which here again is seen to be predominant.

But if the question of the provision of hospital accommodation be considered, or that of temporary inefficiency, it is quite evident that the greater the proportion of an army in the field which is drawn from the civil population of Great Britain, either as specially enlisted corps without any previous training, or in a force which is not maintained constantly under training and observation at home and abroad, the greater will be the demand for hospital accommodation, and the greater the temporary inefficiency.

It is, unfortunately, of little use to attempt to ascertain how the permanent loss, other than by death, was distributed. The opportunities for sending men home were so frequent that invaliding was carried out largely as a means of dealing with temporary inefficiency, and preventing an undue accumulation of sick in the hospitals: it is therefore not a true measure of this loss (see Report on the Medical Arrangements, p. 209). But it is well established that under all conditions there is a constant elimination of the less fit which, usually spread over the first five years of service, is in war accelerated by the stresses of the campaign. The proportion of permanent loss under this head will always be greater in units of the types spoken of above, than in those of the Regular Army, because this process of elimination only begins when these units take the field.

TABLE A.—Composition of Field Force, South Africa. *Sources from which Troops were drawn.* N.C.O.'s and Men.

	To 31.12.00	1.1.01 to 30.9.01	1.10.01 to 31.12.01	1.1.02 to 31.5.02	Totals		
Home.							
Regulars, Units	98,826	5,265	3,506	956	108,553	209,880	Regulars.
Drafts	62,325	14,928	5,547	18,527	101,327		
Imperial Yeomanry, Units ..	9,713	16,553	625	6,751	33,642	34,124	Imperial Yeomanry.
Drafts ..	482	..	..	..	482		
Militia, Units	18,413	6,060	4,179	9,562	38,214	43,071	Militia.
Drafts	3,197	57	..	1,603	4,857		
Volunteer Service Co.'s. Units ..	8,096	5,975	..	2,446	16,517	19,208	Volunteers.
Drafts ..	1,024	..	..	..	1,024		
C.I. Volunteers, Units	1,520	..	..	..	1,520		
Drafts	147	..	..	..	147		
Scottish Horse	..	225	221	371	817	817	Scottish Horse.
S.A. Constabulary	..	5,767	1,109	380	7,256	7,256	S.A. Constabulary.
	203,743	54,830	15,187	40,596	314,356	314,356	—
India.							
Regulars	7,403	..	3,749	958	12,110	17,661	Regulars.
Drafts	..	..	..	5,551	5,551		
Volunteers	289	..	..	..	289	289	Volunteers.
	7,692	—	3,749	6,509	17,950	17,950	—
Colonies.							
Regulars	7,047	680	1,189	..	8,916	8,916	Regulars.
Colonial Contingents	10,773	6,337	..	10,317	27,427	27,748	Colonial Contingents.
Drafts	..	321	..	..	321		
Militia	..	804	..	..	804	804	Militia.
S.A. Constabulary (Canada) ..	..	1,209	..	..	1,209	1,209	S.A. Constabulary.
	17,820	9,351	1,189	10,317	38,677	38,677	—
South African Colonials	..	..	..	..	..	50,090	Raised between 11.10.99 and 30.4.01. Later numbers uncertain.
Garrison, South Africa	9,622	..	..	..	9,622	9,622	—
Total	238,877	64,181	20,125	57,422	380,605	430,695	
	Pages 61, 62, App. R.W.C.	Page 69, App. R.W.C.	Page 73, App. R.W.C.	Page 79, App. R.W.C.			

Detail during First Year.

N.C.O.'s and Men.

Group	Dates of disembarkation	Regulars			Militia	Other Corps	Grand total	Remarks
		Colour Service	Reserve	Total				
Garrison, South Africa	1.8.99	9,622	..	9,622	..	..	9,622	—
Reinforcements, 1st	20.9.99	1,744	..	1,744	..	..	1,744	954 Gibraltar, 790 Home.
,, 2nd	2 to 30.10.99	10,263	..	10,263	..	..	10,263	Home, India, and Mediterraneau.
Field Force	27.10 to 29.12.99	26,492	20,589	47,081	..	..	47,081	—
Reinforcements, 3rd	8.12 to 14.12.99	2,030	1,311	3,341	..	..	3,341	—
5th Division	15.12.99 to 10.1.00	5,252	4,612	9,864	..	..	9,864	—
Brigade Division, R.H. Artillery	10 to 25.1.00	514	220	734	..	..	734	—
6th Division	7 to 21.1.00	5,101	3,476	8,577	..	..	8,577	No Section "D."
7th Division	23.1 to 11.2.00	4,406	4,772	9,178	..	..	9,178	Included Section "D."
4th Cavalry Brigade	1 to 20.3.00	1,580	935	2,515	..	..	2,515	—
Reinforcements from India ..	21.1 to 13.12.00	1,759	..	1,759	..	..	1,759	Not included in Appendix 8, R.W.C.
4th Brigade Division, R.F. Arty.	12 to 24.2.00	1,058	1,471	2,529	..	..	2,529	—
Militia for L. of C.	29.1 to 13.2.00	..	..	..	4,877	..	4,877	—
Siege Train and Heavy Artillery	26.12.99 to 3.5.00	1,539	611	2,150	..	..	2,150	—
With Units not included above	.. .. ..	2,093	511	2,604	..	..	2,604	—
Militia for L. of C.	1.3 to 28.6.00	..	..	..	13,536	..	13,536	—
Reinforcements from Mediterranean	20 to 25.3.00	1,192	930	2,122	..	..	2,122	—
8th Division	3.4 to 10.5.00	5,296	3,519	8,815	..	..	8,815	—
C.I. Volunteers	29.1.00	..	..	..	..	1,520	1,520	—
Volunteer Service Co.'s ..	to	..	..	..	..	8,096	8,096	—
Imperial Yeomanry	28.6.00	..	..	..	..	9,713	9,713	—
Colonial Contingents, 1899, 1900	.. .. ..	..	..	..	..	11,062	11,062	—
Formed Units	.. .. ..	79,941	42,957	122,898	18,413	30,391	171,702	—
Drafts	.. .. ..	30,897	18,414	49,311	3,197	1,653	54,161	—
			13,014*	13,014			13,014	* Militia Reserve. Reserves not embarked after September, 1900.
Total	.. .. ..	110,838	74,385	185,223	21,610	32,044	238,877	—

The total strengths are from Appendix 4, R.W.C.
The details from Appendix 8, R.W.C.

TABLE C.—Ratios per 1,000 of Strength. Admissions and Deaths.

Campaign	Duration, days	Average annual strength	Continued Fevers.						Dysentery		Other disease		All disease		Wounds in action		Other causes, not disease		Total	
			Enteric		Other		Total													
			Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.
Nile Field Force, 1889	36	150	33	6·6	166	..	199	6·6	73	..	378	..	650	6·6	33	6·6	93	6·6	776	19·8
Eastern Soudan, 1884	53	583	..	..	..	..	67	..	..	..	397(*a*)	..	464	..	339	1·7	74	..	877	1·7
Soudan, 1885-86 ..	57	917	103	18·5	167	..	270	18·5	138	4·4	631	3·3	1,040	26·2	47	7·6	60	3·3	1,147	37·1
Suakin Expeditionary Force, 1885	75	1,487	59	7·4	87	..	146	7·4	..	..	1,151(*a*)	3·4	1,297	10·8	67	31·6	80	0·6	1,444	43·0
Egypt, 1882 ..	85	3,036	39	8·9	276	0·3	315	9·2	230	6·9	1,731	8·2	2,276	24·4	125	3·6	103	1·7	2,504	29·7
Chitral Relief Force, 1895	About 180	2,571	127	36·6	41	..	168	36·6	220	7·8	1,088	5·0	1,476	49·4	14	5·0	54	0·4	1,544	54·8
Mashonaland, 1896-97	192	266	60	..	..	..	60	..	128	..	387	3·8	575	3·8	53	15·0	207	..	835	18·8
Dongola Expeditionary Force, 1896	205	575	70	34·8	250	..	320	34·8	16	1·7	556	38·2	892	74·7	..	..	83	7·0	975	81·7
Matabeleland, 1896	211	384	88	28·6	55	..	143	28·6	68	..	263	..	474	28·6	10	2·6	57	..	541	31·2
Nile Expeditionary Force, 1898	255	3,510	85	23·6	206	..	291	23·6	165	4·6	499	3·4	955	31·6	57	15·7	46	4·5	1,058	51·8
Zulu War, 1879 ..	273	9,462	..	..	..	..	295(*b*)	18·5	161(*c*)	5·8	..	..	..	..	17	2·4	532(*d*)	5·9	1,005	32·6
China Field Force, 1900-01	383	1,277	20	7·8	5	..	25	7·8	63	1·6	845	3·9	933	13·3	10	2·3	119	9·4	1,062	25·0
Nile Expeditionary Force, 1884-85	504	7,790	51	18·6	110	0·4	161	19·0	62	4·0	334	3·1	557	26·1	16	2·8	27	2·7	600	31·6
S. African War, 1899-1902	961	208,226	130	18·1	74	0·0	204	18·1	86	3·0	553	3·4	843	24·6	48	2·9	67	1·0	958	28·5
Arithmetical mean*	..	..	..	..	..	..	182·22 ± 17·47		113·5 ± 13·37		..	..	956 ± 90		..	..	..	..	1,102 ± 95	
Variability*	..	..	..	..	..	..	51·24 %		57·95 %		..	..	50·50 %		..	..	..	..	50·46 %	

* Refer to admissions only. (*a*) Includes dysentery. (*b*) Includes malarial fever. (*c*) Includes diarrhœa.
(*d*) Includes also diseases not already mentioned.

TABLE D.—Total Incidence and Mortality per 1,000, and Percentage of these Ratios due to the Causes named.

Campaign	Duration, days	Average annual strength	Continued Fevers						Dysentery		Other disease		All disease		Wounds in action		Other causes, not disease		Ratios of strength per 1,000	
			Enteric		Other		Total													
			Adm.	D.	Adm.	D.	Adm	D.	Adm.	D.	Adm.	D.	Adm	D.	Adm.	D.	Adm.	D.	Adm.	D.
Nile Field Force, 1889	36	150	4·2	$\frac{1}{3}$	21·4	..	25·6	$\frac{1}{3}$	9·4	..	48·8	..	83·8	$\frac{1}{3}$	4·2	$\frac{1}{3}$	12·0	$\frac{1}{3}$	776	19·8
Eastern Soudan, 1884	53	583	..	..	..	..	7·6	..	..	..	45·2(*a*)	..	52·8	..	38·8	100·0	8·4	..	877	1·7
Soudan, 1885-86 ..	57	917	9·0	49·9	14·5	..	23·5	49·9	12·1	11·8	55·0	8·9	90·6	70·6	4·1	20·5	5·2	8·9	1,147	37·1
Suakin Expeditionary Force, 1885	75	1,487	4·1	17·2	6·0	..	10·1	17·2	..	..	79·8(*a*)	7·9	89·9	25·1	4·6	73·5	5·5	1·3	1,444	43·0
Egypt, 1882	85	3,036	1·6	30·0	11·0	1·1	12·6	31·1	9·2	23·3	69·0	27·8	90·8	82·2	5·0	12·2	4·1	5·6	2,504	29·7
Chitral Relief Force, 1895	About 180	2,571	8·2	66·7	2·7	..	10·9	66·7	14·2	14·2	70·5	9·2	95·6	90·1	0·9	9·2	3·5	0·7	1,544	54·8
Mashonaland, 1896-97	192	266	7·2	..	..	..	7·2	..	15·3	..	46·4	20·0	68·9	20·0	6·3	80·0	24·8	..	835	18·8
Dongola Expeditionary Force, 1896	205	575	7·1	42·6	25·7	..	32·8	42·6	1·6	2·1	57·1	46·8	91·5	91·5	..	..	8·5	8·5	975	81·7
Matabeleland, 1896..	211	384	16·4	91·6	10·1	..	26·5	91·6	12·5	..	48·5	..	87·5	91·6	1·9	8·4	10·6	..	541	31·2
Nile Expeditionary Force, 1898	255	3,510	8·0	45·6	19·4	..	27·4	45·6	15·6	8·8	47·1	6·6	90·1	61·0	5·4	30·2	4·4	8·8	1,058	51 8
Zulu War, 1879 ..	273	9,462	..	..	..	..	29·3(*b*)	56·6	16·0(*c*)	17·8	..	..	..	..	1·7	7·4	53·0(*d*)	18·1	1,005	32·6
China Field Force, 1900-01	383	1,277	1·9	31·3	0·4	..	2·3	31·3	5·9	6·2	79·5	15·6	87·9	53·1	1·0	9·4	11·1	37·4	1,062	25·0
Nile Expeditionary Force, 1884-85	504	7,790	8·5	58·8	18·3	1·3	26·8	60·1	10·3	12·7	55·8	9·8	92·9	82·5	2·7	8·9	4·3	8·5	600	31·6
S. African War, 1899-1902	961	208,226	13·6	63·5	7·7	0·2	21·3	63·5	9·0	10·5	57·7	12·0	88·0	86·0	5·0	10·2	7·0	3·1	958	28·5

(*a*) Includes dysentery. (*b*) Includes malarial fevers. (*c*) Includes diarrhœa. (*d*) Includes also diseases not already mentioned.

TABLE E.—INCIDENCE AND MORTALITY, CONTINUED FEVERS.

Officers.

	Regulars and Volunteers				Imperial Yeomanry				Regulars, Volunteers, and Imperial Yeomanry				Colonials				Total			
Exposed to risk :	13,467				1,487				14,954				4,479				19,433			
	Cases	Per 1,000	Deaths	Per 1,000	Cases	Per 1,000	Deaths	Per 1,000	Cases	Per 1,000	Deaths	Per 1,000	Cases	Per 1,000	Deaths	Per 1,000	Cases	Per 1,000	Deaths	Per 1,000
Enteric fever	1,920	142·57 ±2·03	183	13·59 ±0·67	180	121·05 ±5·70	22	14·75 ±2·11	2,100	140·43 ±1·92	205	13·71 ±0·64	318	71·00 ±2·59	35	7·81 ±0·79	2,418	124·43 ±1·17	240	12·34 ±0·53
	1,648		157		150		18		1,798		175		268		30		2,066		205	
Simple continued fever	1,144	84·95 ±1·62	—	—	114	76·66 ±4·65	—	—	1,258	84·12 ±1·53	—	—	167	37·28 ±2·83	—	—	1,425	73·33 ±1·26	—	—
	982		—	—	95		—	—	1,077		—		141		—	—	1,218		—	
Total ..	3,064	227·52 ±2·44	183	13·59 ±0·67	294	197·72 ±6·97	22	14·75 ±2·11	3,358	224·55 ±2·30	205	13·71 ±0·64	485	108·28 ±3·13	35	7·81 ±0·79	3,843	197·75 ±1·93	240	12·34 ±0·53
	2,630		157		245		18		2,875		175		409		30		3,284		205	

Other Ranks.

Exposed to risk :	415,019				30,682				445,701				102,536				548,237			
Enteric fever	55,970	134·87 ±0·36	8,041	19·37 ±0·14	5,923	193·05 ±1·52	800	26·07 ±0·61	61,893	138·87 ±0·35	8,841	19·84 ±0·14	9,322	90·91 ±0·60	1,063	10·36 ±0·21	71,215	129·90 ±0·31	9,904	18·06 ±0·12
	45,401		6,523		4,921		665		50,322		7,188		7,362		834		57.684		8,022	
Simple continued fever	33,442	80·58 ±0·28	28	0·07	2,493	81·25 ±1·05	—	—	35.935	80·63 ±0·27	28	0·06	4,846	47·26 ±0·45	—	—	40,781	74·38 ±0·24	28	0·05
	27,130		23		2,074				29,204		23		3,829		—		33,033		23	
Total ..	89,412	215·45 ±0·43	8,069	19·44 ±0·14	8,416	274·30 ±1·72	800	26·07 ±0·61	97,828	219·50 ±0·42	8,869	19·90 ±0·14	14,168	138·17 ±0·73	1,063	10·36 ±0·21	111,996	204·28 ±0·37	9,932	18·11 ±0·12
	72,531		6,546		6,995		665		79,526		7,211		11,191		834		90,717		8,045	

Officers.

Exposed to risk :	13,467				1,487				14,954				4,479				19,433			
Dysentery	1,204	89·45 ±1·66	32	2·38 ±0·28	137	92·13 ±5·06	4	2·69 ±0·91	1,341	89·67 ±1·58	36	2·41 ±0·27	152	33·94 ±1·82	6	1·34 ±0·37	1,493	76·83 ±1·29	42	2·16 ±0·22
	1,034		28	—	114		3	—	1,148	—	31	—	128	—	5	—	1,276	—	36	—
Diarrhœa	757	56·21 ±1·34	—	—	79	53·13 ±3·92	—	—	836	55·90 ±1·28	—	—	74	16·52 ±1·28	—	—	910	46·83 ±1·02	—	—
	650		—	—	66		—		716	—	—	—	62	—	—	—	778	—	—	—
Inflammation of intestines	217	16·11 ±0·73	2	0·15	25	16·81 ±2·25	—	—	242	16·18 ±0·69	2	0·13	26	5·80 ±0·76	—	—	268	13·79 ±0·56	2	0·10
	186		2	—	21		—	—	207	—	2	—	22	—	—	—	229	—	2	—
Total ..	2,178	161·73 ±2·14	34	2·53 ±0·28	241	162·07 ±6·45	4	2·69 ±0·91	2,419	161·76 ±2·03	38	2·54 ±0·28	252	56·26 ±2·38	6	1·34 ±0·37	2,671	137·45 ±1·67	44	2·26 ±0·23
	1,870		30		201		3		2,071	—	33	—	212	—	5	—	2,283	—	38	

Other Ranks.

Exposed to risk :	415,019				30,682				445,701				102,536				548,237			
Dysentery	38,483	92·73 ±0·30	1,361	3·28 ±0·06	3,214	104·75 ±3·90	111	3·62 ±0·23	41,697	93·56 ±0·29	1,472	3·30 ±0·06	5,343	52·11 ±0·47	186	1·81 ±0·11	47,040	85·81 ±0·26	1,658	3·02 ±0·05
	31,287	—	1,106	—	2,591	—	90	—	33,878	—	1,196	—	4,230	—	147	—	38,108	—	1,343	—
Diarrhœa	18,360	44·24 ±0·21	25	0·06	1,980	64·53 ±0·95	—	—	20,340	45·64 ±0·21	25	0·06	2,770	27·01 ±0·34	—	—	23,110	42·15 ±0·18	25	0·05
	14,927	—	20	—	1,596		—	—	16,523	—	20	—	2,193	—	—	—	18,716	—	20	—
Inflammation of intestines	1,647	3·97 ±0·07	47	0·11	139	4·83	—	—	1,786	4·00 ±0·06	47	0·10	362	3·53 ±0·12	10	0·10	2,148	3·92 ±0·06	57	0·10
	1,339	—	38	—	112		—	—	1,451	—	38	—	287	—	8	—	1,738	—	46	—
Total ..	58,490	140·94 ±0·38	1,433	3·45 ±0·06	5,333	173·82 ±1·46	111	3·62 ±0·23	63,823	143·20 ±0·35	1,544	3·46 ±0·06	8,475	82·65 ±0·58	196	1·91 ±0·09	72,298	131·88 ±0·31	1,740	3·17 ±0·05
	47,553		1,163		4,299		90		51,852	—	1,254	—	6,710	—	155	—	58,562	—	1,409	—

Note.—The lighter figures are the actual numbers as taken from our records.

TABLE G.—COMPARATIVE INCIDENCE, MORTALITY AND CASE MORTALITY AMONG INOCULATED AND NON-INOCULATED, SOUTH AFRICAN WAR, 1899—1902.

Corps	Strength Embarked			Inoculated		Non-inoculated		Total Ratios per 1,000		Incidence per 1,000		Mortality per 1,000		Case Mortality per 100.	
	Total	Inoculated	Non-inoculated	Cases	Deaths	Cases	Deaths	Incidence	Mortality	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated
Household Cavalry ..	694	104	590	10	–	192	35	291·1 ±11·6	50·43 ±5·6	96·15 ±19·49	325·42 ±13·00	–	59·32	–	18·2
Cavalry	20,625	1,491	19,134	107	4	4,384	617	217·3 ±1·9	30·05 ±0·8	71·76 ±4·51	229·12 ±2·05	2·68	32·26	3·7	14·1
Imperial Yeomanry..	35,170	1,508	33,662	162	22	4,759	643	139·9 ±1·2	18·9 ±0·5	107·43 ±9·19	141·38 ±1·30	14·59	19·10	13·6	13·5
Royal Artillery ..	19,636	1,265	18,371	150	11	3,931	546	207·8 ±1·9	28·4 ±0·8	118·58 ±6·13	213·98 ±2·04	8·69	29·72	7·3	13·9
Royal Engineers ..	7,871	677	7,194	66	12	1,540	234	204·0 ±3·1	31·2 ±1·3	97·49 ±4·90	214·06 ±3·26	17·73	32·53	18·2	15·2
Guards	11,575	976	10,599	140	* 12	2,015	284	186·2 ±2·4	25·6 ±1·1	143·45 ±21·32	190·11 ±2·30	12·29	26·79	8·6	14·1
Infantry	215,129	6,523	208,606	537	72	28,409	4,120	134·5 ±0·5	19·5 ±0·2	82·32 ±2·30	136·18 ±0·51	11·04	19·75	13·4	14·5
C.I. Volunteers ..	1,666	935	731	81	16	131	23	127·3 ±5·5	23·4 ±2·5	86·60 ±6·20	179·20 ±9·57	17·11	31·46	19·8	17·6
Army Service Corps..	5,911	74	5,837	8	1	1,391	205	236·7 ±3·73	34·8 ±1·6	108·11 ±24·34	238·30 ±3·76	13·51	35·12	12·5	14·7
R.A.M. Corps ..	8,634	1,030	7,604	154	13	1,745	234	220·9 ±3·0	28·6 ±1·2	149·51 ±7·50	229·40 ±3·25	12·62	30·77	8·4	13·4
Army Ordnance Corps	1,333	43	1,290	2	–	257	50	194·3 ±7·3	37·5 ±3·5	46·51 ±21·65	199·22 ±7·50	–	38·76	–	19·5
Totals and average ratios	328,244	14,626	313,618	1,417	163	48,754	6,991	196·4 ±9·4	29·86 ±1·73	100·72 ±5·81	208·76 ±9·98	10·02 ±1·24	32·32 ±2·08	9·6 ±0·98	15·3 ±0·41

* All in the Grenadier Guards.

Notes.—(1) R.A.M. Corps: St. John Ambulance Brigade are included. The following Corps have been omitted: Army Pay Corps, Military Police, Army Post Office Corps.

(2) The probable differences show that the distinction between the incidence in the two classes is significant, except in the Guards, but it has to be noted that the twelve cases among inoculated occurred in *one* battalion of the Grenadiers. It may also be noted that in the Imperial Yeomanry the distinction between the two classes is not very well marked.

(3) Probable errors have not been calculated for the mortality rates. It is evident that among the inoculated cases such errors must be very great, and the error of the average mortality in each class appears sufficient.

(4) The average ratios are the arithmetical mean of those shown against each Corps.

TABLE H.

A. Officers. EFFECTS OF HEAT, SOUTH AFRICA, 1899-1902.

	Regulars and Volunteers			Imperial Yeomanry			Regulars, Volunteers, and Imperial Yeomanry			Colonials			Total		
	13,467			1,487			14,954			4,479			19,433		
	Cases	Incidence per 1,000	D.	Cases	Incidence per 1,000	D.	Cases	Incidence per 1,000	D.	Cases	Incidence per 1,000	D.	Cases	Incidence per 1,000	D.
Sunstroke	42	3·12	2	10	6·72	..	52	3·48	2	13	2·90	..	65	3·34	2
Heatstroke	26	1·93	..	2	1·35	..	28	1·87	..	4	0·89	..	32	1·65	..
Heat apoplexy	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total	68	5·05 ± 0·41	2	12	8·07 ± 1·56	..	80	5·35 ± 0·40	2	17	3·79 ± 0·62	..	97	4·99 ± 0·34	2

B. Warrant and N.C.O.'s and Men.

	415,018			30,682			445,700			102,518			548,218		
Sunstroke	748	1·80	4	110	3·59	3	858	1·93	7	95	0·93	1	953	1·74	8
Heatstroke	397	0·96	1	51	1·66	..	448	1·00	1	56	0·55	..	504	0·92	1
Heat apoplexy	61	0·14	3	1	0·03	..	62	0·14	3	9	0·08	1	71	0·13	4
Total	1,206	2·90 ± 0·06	8	162	5·28 ± 0·28	3	1,368	3·07 ± 0·06	11	160	1·56 ± 0·08	2	1,528	2·79 ± 0·05	13